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The SCIENTIFIC MONTHLY

May 1944

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Smithsonian Institution Building, Washington 25, D. C.

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KEEPING UP WITH
Electricity

BROADCASTING TIN. "Flowing" tin plate by induction heating is now accepted practice in the industry. Frequency used in the first installation was 200,000 cycles per second—and the equipment was salvaged from a discarded broadcasting unit! Incidentally, this first installation is still in daily use.

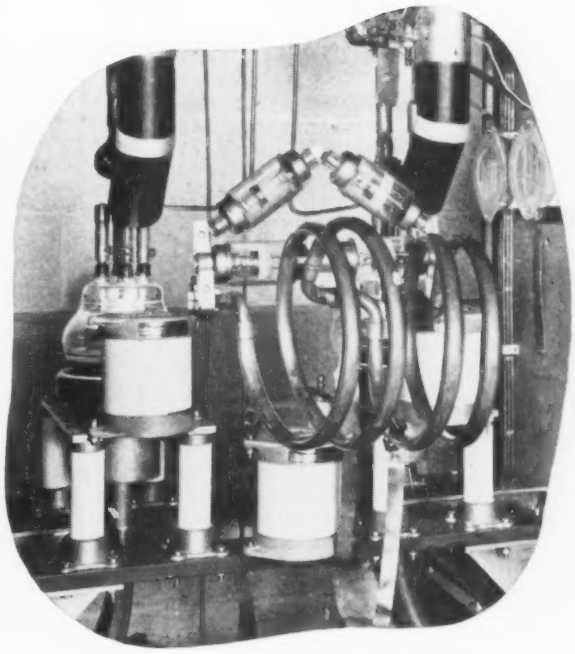
IT'S A MATTER OF SPEED. Radium gives out 1,200,000 times as much energy as the same weight of coal burned with oxygen. Even if we had plenty, however, it would probably be a poor substitute for coal, since it releases energy only one-eightieth as rapidly. Nothing that scientists have been able to do has had the slightest effect in speeding up the process.

THE SUN IS STILL SLOWER, releasing energy by a process which involves the transmutation of elements and takes between six and seven million years.

WOMAN'S WEAPON. One reason that electric irons aren't being made is that the thermostats used to control their temperature are busy on land, sea and air. They're guarding against motor trouble in tanks, fire danger in planes, overheating in gun equipment on battleships.

PEAK FLATTENERS. Resistance welders have speeded up production in thousands of war plants, but they have imposed enormous on and off single-phase loads on power circuits, often building up impossible peak demands. Capacitors are proving to be the answer, correcting the power factor to approximate unity.

THE HIGHER, THE FEWER no longer applies in radio vibrators. At high altitudes, vibrator contacts literally "boiled away" in ten hours, hence this type of radio was seldom used in airplanes. New-type vibrator, using Westinghouse-developed materials and techniques, has a life expectancy equal to that of the plane.



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THE SCIENTIFIC MONTHLY

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Founding and Organization

In 1848, on September 20, the Association was formally organized and held its first meeting; in 1874 it was incorporated under the laws of the Commonwealth of Massachusetts and given the right to receive, purchase, hold and convey property. Its governing body is a Council, now having 255 members.

The Association is national in scope, with membership open to the whole world on equal terms, and its interests include the broad fields of the natural and the social sciences. Its varied activities are carried on under 16 sections with which 189 affiliated and associated societies, having a combined membership of nearly a million, cooperate in organizing programs for its meetings.

Members and Meetings

All persons engaged in scientific work, all who find pleasure in following scientific discoveries, all who believe that through the natural and social sciences a better society may be achieved are eligible for membership in the Association. From its founding, the most distinguished of American scientists, including every American Nobel Laureate in science and every president of the National Academy of Sciences, have been members. The names of many university presidents, of eminent scholars in widely different fields, and of men notable for public service, including a United States Senator, a Justice of the Supreme Court, and a former president of the United States, are now on its roll of more than 25,000 members.

The Association's meetings are field days of science attended by thousands of participants at which hundreds of scientists vie with one another for the pleasure and the honor of presenting results of researches of the greatest benefit to their fellow men. An enlightened daily press reports their proceedings throughout the country.

Opportunity and Responsibility

A world torn by conflicts and fearful of the future is looking more and more toward scientists for leadership. The opportunity for unparalleled service is theirs and the fact that they have available the only essentially new methods, if not purposes, imposes an equal responsibility. For these reasons it will be the Association's steadfast purpose to promote closer relations among the natural and the social scientists, and between all scientists and other persons with similar aspirations, to the end that they together may discover means of attaining an orderliness in human relations comparable to that which they find in the natural world about them.

MEET THE AUTHORS

E. C. AUCHTER, Ph.D., is Administrator of Agricultural Research of the wartime Agricultural Research Administration, U. S. Department of Agriculture, Washington, D. C. In 54 years he advanced from his birthplace on a farm near Rochester, N. Y., to the leadership of one of the largest research organizations in the world. Starting his education in a country schoolhouse, he finished it formally at Cornell, where he took all his degrees, his doctorate being in plant physiology. By the time he had taken his Ph.D. in 1922, he had already traveled throughout the United States, had been a specialist in horticulture at West Virginia University, and had become head of the Department of Horticulture at the University of Maryland. In 1928 he entered the Department of Agriculture as head of the newly organized Division of Horticultural Crops and Diseases, Bureau of Plant Industry. In 1935 he became Assistant Chief of this Bureau and in 1938, Chief. In 1941 he was chosen to head the new ARA. Dr. Auchter's scientific specialty is fruit culture, on which he has written two books with H. B. Knapp.

GOVE HAMBIDGE, A.B., is Coordinator of Information and Publications, ARA, and a close associate of Dr. Auchter. He was born in Kansas City, Mo., in 1890, the son of a newspaper man. Having received a more or less peripatetic schooling in the East and in England, Mr. Hambidge concentrated in English literature and writing at Columbia University and graduated in 1913. Space is lacking to describe his subsequent varied career as writer and editor. His freelancing from 1927 to 1935 was combined with farming and traveling, which no doubt led to his appointment as editor of the *Yearbook of Agriculture* of the USDA (1935–1942). His carefree period of freelancing was celebrated in two books: *Time to Live* and *Enchanted Acre*. He has also written: *Six Rooms Make a World*, *The Prime of Life*, and *Your Meals and Your Money*.

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NEW BOOKS

New Goals for Old Age. Edited by GEORGE LAWTON. ix + 210 pp. 1943. $2.75. Columbia University Press.

Fourteen contributors, including social workers, psychologists, medical men, and institutional heads, discuss the nature and needs of older people—their abilities and limitations, their relations to the community and the family, and their potential contributions to society.

Mr. Tompkins Explores the Atom. G. GAMOW. Ill. x + 97 pp. April, 1944. $2.00. Macmillan.

Through the adventurous nightmares of Mr. Tompkins, a bank employee, and the lectures of his father-in-law, the professor, the uninitiated are made familiar with some of the basic theories of modern physics. The whimsical presentation includes instruction on the nature of matter; particularly, saturated electronic shell, nuclear potential barriers, etc.

Miracles Ahead! NORMAN V. CARLISLE and FRANK B. LATHAM. xi + 288 pp. April, 1944. $2.75. Macmillan.

This book projects a future of aviation, electronics, and chemical wonders based on what scientists and industrialists think can be done to provide "better living in the postwar world." It surveys widely the miracles of today and predicts those to come: materials, homes, appliances, agriculture, food, medicine, etc.

Riddles in Mathematics. EUGENE P. NORTHROP. Ill. viii + 262 pp. $3.00. Van Nostrand.

This is a book of paradoxes for both the amateur and professional interested in problems of mathematical equations and in basic reasoning. Over two hundred riddles provide entertainment and instruction in arithmetic, algebra, geometry, trigonometry, and calculus.

How to Think About War and Peace. MORTIMER J. ADLER. xxiv + 307 pp. 1944. $2.50. Simon and Schuster.

Dr. Adler tackles the problem, possibility, probability, and practicality of a lasting world peace as opposed to truce between wars. He envisages a world community which must be a society of men and urges that plans be examined for their implicit principles.

The Permeability of Natural Membranes. HUGH DAVSON and JAMES FREDERIC DANIELLI. Ill. x + 361 pp. Jan., 1944. $4.75. Cambridge, at the University Press; New York, The Macmillan Co.

The authors, of University College, London, and St. John's College, Cambridge, respectively, have written a scholarly account of what is now known about the quantitative aspects of the selective permeability of the membranes of living cells.

Beloved Scientist. DAVID O. WOODBURY. Ill. xiii + 358 pp. Jan., 1944. $3.50. Whittlesey House, McGraw-Hill.

The subtitle is "Elihu Thompson: A Guiding Spirit of the Electrical Age." Perhaps the most pleasant way to become informed about the development of a branch of science or technology is to read a good biography of a pioneer and leader of it. This biography of one of the great electrical "wizards" takes the reader through the development of electrical engineering.

MEET THE AUTHORS, Continued

RAYMOND E. JANSSEN, Ph.D., is Assistant Professor of Geology at Marshall College, Huntington, West Virginia. He was born in Springfield, Ill., in 1903 and received his college education at Northwestern and The University of Chicago. His teaching is not confined to the campus, but through his six popular books on such subjects as fossil plants, soil, and coal, his magazine and encyclopedia articles, and his museum exhibits he reaches a larger public. He has had extensive experience in the design of geological exhibits; for example, for the Field Museum, Chicago Century of Progress Exposition, Museum of Science and Industry, and the Texas Centennial Exposition. His principal research deals with the paleobotanical origin of coal, and he is an authority on the fossil plant impressions in the Pennsylvanian strata of Illinois and eastern coal fields. Dr. Janssen also finds time to study (primarily for fun) the tree markers of Indian trails.

MARY ELLEN GOODMAN, Ph.D. (prospective), is a graduate student in anthropology at Radcliffe College and the wife of Dr. Clark Goodman, Assistant Professor of Physics at the Massachusetts Institute of Technology. As Mary Ellen Hohiesel, she was born in Los Angeles in 1911 and emerged from the University of California at Los Angeles as a primary school teacher. Dr. Goodman made off with her in 1933 and in 1938 she resumed her studies, at Radcliffe. She is concentrating in social anthropology with particular reference to the problems of minority peoples and race relations. Mrs. Goodman is writing a thesis on the nature and origin of interracial attitudes in Negro and in white children of three and one-half to four and one-half years. We risk the wrath of the Goodmans by remarking that Mrs. Goodman's photograph is her most noteworthy contribution to *The Scientific Monthly*. She is our candidate for the girl-we-would-most-like-to-meet-in-Shangri-La.

MEET THE AUTHORS, Continued

GILES B. COOKE, Ph.D., is in charge of research and development on cork and rubber in the Research Department of the Crown Cork & Seal Company, Baltimore, Maryland. He is a Virginian, born in Gloucester in 1897 and a graduate of William and Mary College. After serving as principal of consolidated rural high schools in Virginia, he went to the University of Maryland for graduate work in chemistry and took his doctorate in 1929. He then joined the research staff of the Armstrong Cork Company. In 1932 he returned to the University of Maryland to teach chemistry and in 1934 joined his present employers. His developmental work on cork and rubber has resulted in a number of patents. During the past four years he has been very active in all phases of the Cork Project described in his present article. Dr. Cooke has taken great pains to make this article correct as of March, 1944.

Photograph by Bachrach

ALAN GREGG, M.D., is Director for the Medical Sciences of the Rockefeller Foundation, 49 West 49th St., New York 20. He was born in 1890 in Colorado Springs and received his premedical and medical education at Harvard. During the first World War he served abroad as a medical officer in a general hospital. He joined the Rockefeller Foundation in 1919 and was sent to Brazil for three years on hookworms. He then entered the Division of Medical Education of the Foundation and from 1924 to 1931 his headquarters were in Paris while he studied medical education and the organization of research in the medical schools of all European countries. His foreign travels continued until 1940, covering most of the world. In 1941 he delivered the Terry Lectures at Yale on "The Furtherance of Medical Research." Dr. Gregg's professional interests are in psychiatry and public health; nonprofessional, in travel, languages, and pigeon breeding. He is a member of the School Board in Searsdale, N. Y.

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MEET THE AUTHORS, Continued

STANLEY W. BROMLEY, Ph.D, is Entomologist for the Barlett Tree Research Laboratories, Stamford, Conn. He was born at Charlton, Mass., in 1899. On the farm where he grew up, he became aware of hawks and other birds in which in later years he retained a secondary interest, heightened by his appointment in 1918 as a Massachusetts State Bird Observer. After the first World War, in which he was an enlisted man, he decided to become a professional scientist as a result of his work on shatter-proof glass under Dr. E. D. Tillyer of the American Optical Company. He went to the school then called Massachusetts Agricultural College and graduated in 1922. Going ahead in entomology, he became a "gradual" student at The Ohio State University while he served as an entomologist in the U. S. Bureau of Entomology (1922), in the American Cyanamid Company (1923–29), and with his present employers. During the past two years he has been in charge of Camouflage Spray Research.

Koen's Studio

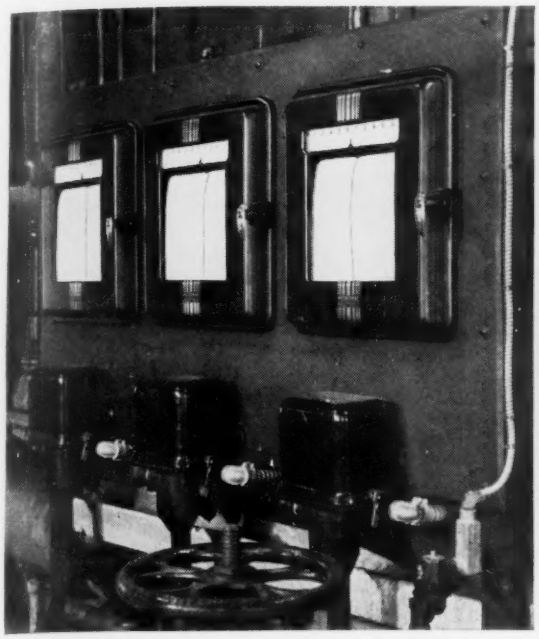
ARCHIE J. BAHM, Ph.D., is Associate Professor of Philosophy and Sociology in Texas Technological College. Born in Michigan in 1907, graduate of Albion College (1929) and of the University of Michigan (1933), he has been teaching in Texas Tech since 1934. He is Secretary-Treasurer of the Southwestern Philosophical Conference, Regional Secretary of the American Humanist Association, Regional Consultant for the American Institute of Family Relations, Contributing Editor to *Philosophic Abstracts*, contributor to Runes' *Dictionary of Philosophy*, and author of a chapter on "Personality" in Pendell's *Society Under Analysis*. He is engaged currently in studying "The New Individualism," a sociological theory interpreting man and society as both complexly composed yet organically integrated; as involving levels of being, levels of control, levels of freedom, and as involving constant change and readjustment.

MEET THE AUTHORS, Continued

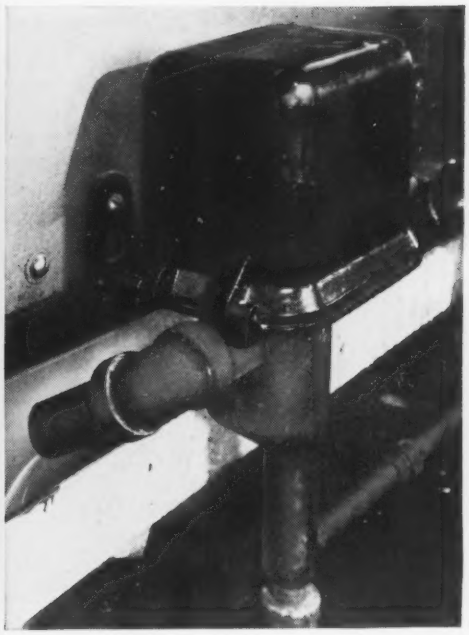
PRIVATE VICTOR W. VON HAGEN is at once an ethnographer, explorer, and author, and now, for the duration, a soldier. Born in St. Louis in 1908, a descendant of noble German émigrés of 1848, he was educated at the Morgan Park Military Academy and at universities in the United States, England, and South America. Exploration began with his majority and he has conducted expeditions into Mexico, the Amazon, Galápagos Islands, Peru, Ecuador, Honduras, and the Mosquito Coast of Nicaragua. His first interest was in the distribution of termites, which gave way to ethnology; then to geography and zoögeography. Now all these have become synthesized into an all-embracing interest—ethnography. Before Mr. von Hagen attained his present proud title, he wrote fifteen books and more than two hundred articles. His latest book, *The Aztec and Maya Papermakers*, was selected by the Institute of Graphic Arts as "one of the fifty best books of 1943."

Voorhis Studio

STEPHEN S. VISHER, Ph.D., is Professor of Geography at Indiana University where he has taught for twenty-five years. He first became conscious of the weather in Chicago (The Windy City) where he was born in 1887. He received his doctorate from the University of Chicago (1914) in geography and geology, after having taught for three years in the rigorous weather of South Dakota. Then followed three years in the unregulated climate of Minnesota and one (1918) as land classifier for the U. S. Geological Survey, before Dr. Visher settled down in the Hoosier State to tell his students, colleagues, and the readers of *The Scientific Monthly* about the weather. Of course he left Bloomington from time to time for summer teaching or for special assignments, once spending a year with the Australian Weather Bureau. Dr. Visher is also interested in environmental influences conducive to the development of leaders.



Located in the filter plant of Arkwright Corp., these three Micromax pH Records show, left to right, the pH of finished water at the clear well, pH just after alum and filters, pH of water coming into plant.



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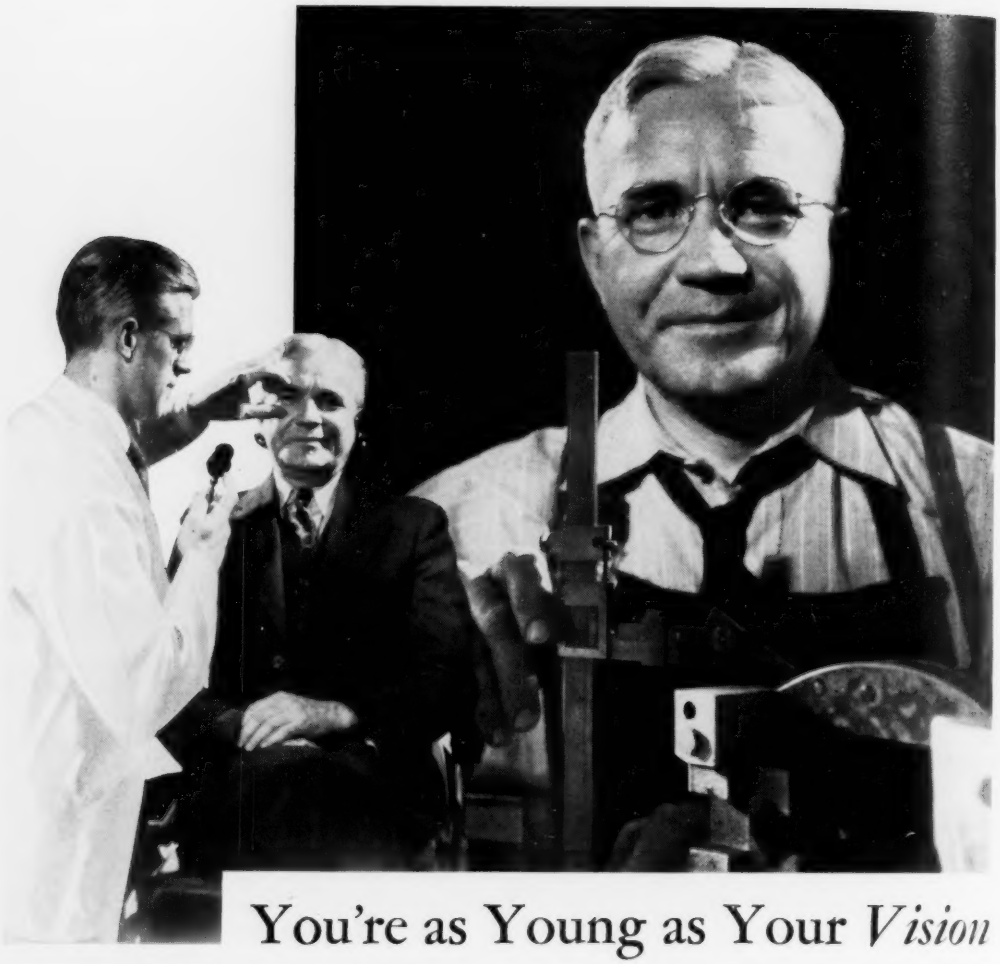

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THE SCIENTIFIC MONTHLY

MAY, 1944

PLOWSHARES INTO SWORDS

By E. C. AUCHTER and GOVE HAMBIDGE

SIGNIFICANTLY, *ara* is the Latin word for *the plow*, root of the Latin verb meaning *to plow* (*arare*) and of the English word *arable*. By a happy accident, the initials ARA in our alphabetized Government agencies stand for the Agricultural Research Administration. The plow, the man behind the plow, the draft animal or tractor that draws the plow, the crops that follow the plow—all these are part of the complex of associations clustering around the name ARA. It would be hard to find a name that better symbolizes things agricultural.

Late in 1941, in the first of the wartime reorganizations of the U. S. Department of Agriculture, ARA was created by grouping most of the research agencies into one unit, with an administrative head responsible for planning, coordinating, and directing the work and focusing it on the solution of war problems. Seven agencies are included in this unit: Agricultural and Industrial Chemistry; Animal Industry; Dairy Industry; Entomology and Plant Quarantine; Experiment Stations; Human Nutrition and Home Economics; and Plant Industry, Soils, and Agricultural Engineering. It also has charge of the Beltsville Research Center. The Center consists of farms, greenhouses, and laboratories handy to Washington where scores of research programs are carried on, primarily by these agencies but also by some others in the Department.

Thus ARA pulls together and integrates most of the research in the natural sciences carried on by the Department; and this represents a very wide range. A map in the central office shows that geographically the field stations and laboratories of ARA agencies—including four big regional laboratories devoted to industrial uses of farm products and nine Bankhead-Jones laboratories carrying on rather fundamental research—are sprinkled over the length and breadth of the country. In addition, research projects in cooperation with the Federal Government are conducted by State experiment stations in every State through ARA's Office of Experiment Stations.

This varied and widespread network of research is not new, nor for the most part are the agencies conducting it; the Department of Agriculture has long been known as one of the leading organizations in research in the world. What is new is the closer coordination of all research, made possible by unified planning and direction; the stimulus and drive that result from the challenge of wartime; and a large number of projects arising directly from the necessities of war.

WANTED—MORE OF EVERYTHING

At the beginning of the war the research work of the ARA agencies was carefully reviewed and much of it was modified, within the framework of legislative authorization, to bear as directly as possible on war needs. In this process, long-time basic research, on which much money had been spent, was not abandoned but set aside; valuable material, such as breeding stocks and experimental orchards, has been preserved and maintained, so that at the end of the war the work can be picked up again where it was interrupted.

The nature and objectives of agricultural research during the war are largely determined by the fact that for one reason or another war creates shortages of practically

everything: of materials, of men, of space, of time itself. Some of the resulting problems can be met by applying the knowledge accumulated through many years of research in the past—knowledge that has proved to be a war chest of immense value. Other problems must be met by new research, and these the agricultural scientists are attacking successfully.

The main types of problems ARA is called upon to solve at this time are these:

Bigger and better crops. There will never be too much of the essential agricultural products to meet the combined needs of the home front and battle front during the war, however generous the supplies may be in relation to peacetime demands. Science is asked to find ways to increase production.

Protection of crops and livestock. Waste is inexcusable in war (except the astronomical waste represented by war itself). Research must redouble its efforts to protect crops and livestock from their natural enemies.

Shortages of feeds and foods. Good management of the country's supplies of livestock feeds and human foods in wartime calls for a background of thorough scientific knowledge. At stake are the efficiency and health of the Nation, including its armed forces.

Shortages of other agricultural products. Many essential products are either no longer available because supplies are cut off by war, or scarce because they are diverted to direct war uses. We must learn to grow things we have not grown before—or find suitable substitutes.

Help for consumers at home. In scores of ways, consumers need help in solving wartime problems vital to their well-being. Much of this help must be in the form of information that is impartial, accurate, and backed by adequate research.

Demands of the armed services and other agencies. Agricultural research is called on to help in solving many special problems of the armed services and other war agencies.

Without writing at great length, it would be impossible to give a complete picture of all the agricultural research that has been done or is being done under these general headings. Out of the mass, only a few examples can be given as important illustrations.

Bigger and Better Crops

How the Plant Breeder Steps Up Pork Production. One of the most striking achievements of modern plant breeding is hybrid corn. Not a war development, it nevertheless came precisely in time, like many another product of agricultural research in recent years, to have a telling effect on our wartime food supply.

In 1933 hybrid corn was making a modest debut on one-tenth of one percent (143,000 acres) of the corn acreage in the United States. By 1938 it occupied about 15 percent. Last year, 1943, it took about 52 percent—some 15 million acres more than in 1941. In the heart of the corn belt, Iowa, 98 to 100 percent of the corn acreage in every county was planted to hybrid seed last year. The same was true in two-thirds of the counties in Illinois, and half the counties in Indiana.

From the standpoint of war production, the significance of this amazingly rapid spread is that hybrid corn consistently outyields open-pollinated varieties by 20 percent. Planting hybrid corn, then, means increasing production by one-fifth without using more acres or manpower. One statistically minded plant breeder estimates that in 1942 about 630,000,000 more bushels of corn were produced through the use of hybrid varieties than would have been possible without them, and that this amount of corn would make 6,900,000,000 pounds of pork. Thus a large share of our wartime pork production can be attributed to the work of plant breeders. Hybrid corn is only one of many contributions plant breeders have recently made to bigger and better crops that fit war needs.

No More Cows But Much More Milk. Dairying offers an example of the enormous potential increases in production, not by any means fully realized, that can be brought about by research.

There are some 26 million dairy cows in the United States. The average production of these cows is around 4,700 pounds of milk a year; it has been rising steadily for many years through the use of more scientific prac-

U.S.D.A. Photograph by Purdy

POLLINATING CORN ARTIFICIALLY FOR PRODUCTION OF A HYBRID

HYBRID CORN, DEVELOPED AS A RESULT OF RESEARCHES IN GENETICS, EXEMPLIFIES THE INFLUENCE OF THEORETICAL SCIENTIFIC RESEARCH IN REVOLUTIONIZING PRACTICES FOR PRODUCTION OF AGRICULTURAL CROPS.

tices. But scattered throughout the country are Dairy Herd Improvement Associations, controlling some 800,000 cows, the average production of which is over 8,000 pounds of milk a year. This figure is not a record but a practical achievement by practical farmers; the present world's record production is 41,943 pounds, and in the experimental herd of the U. S. Department of Agriculture at Beltsville, Maryland, the average production of cows on test is about 16,000 pounds.

DHIA herds, of course, are better fed and better managed than average cows, but much of their superior producing ability is due to breeding. Dairy geneticists in the Department of Agriculture believe that a greatly widened and intensified breeding program would rapidly raise the production of dairy herds throughout the United States toward the DHIA level. The geneticists have elaborate figures to back up their opinion, including records, collected during the past six years, of thousands of bulls that have been proved to be capable of siring daughters that will produce more milk and butterfat than their dams. In most herds production fluctuates up and down from generation to generation because of the haphazard use of good and bad sires. The consistent use of proved sires, the geneticists believe, would steadily and surely raise production levels. Other things being equal, the average production of our herds might be almost doubled without adding a single cow to the dairy population. Any such achievement would require a large-scale program, including much greater use of artificial insemination. By this technique, the inheritance of a good bull can be spread over eight or ten times as many cows as by natural methods.

U.S.D.A. Photograph by Peter Killian

ADMINISTERING PHENOTHIAZINE TO REMOVE WORMS FROM A SHEEP

ZOOLOGISTS OF THE U. S. DEPARTMENT OF AGRICULTURE, WHO DISCOVERED THE VALUE OF THIS NEW DRUG AS LIVESTOCK MEDICINE, RECENTLY DEVELOPED A METHOD FOR ADMINISTERING IT IN THE ANIMAL'S SALT LICK.

Meanwhile, the dairy scientists are going ahead as extensively as facilities permit to spread the use of proved sires. The records show a steady rise in production where these sires are used.

Protection Against Natural Enemies

In spite of everything that is done to combat diseases and insects, they continue to take a heavy toll among our crop plants and livestock. Each advance, however, means that the losses due to some disease or insect or parasite are reduced, even though they may not be completely eliminated.

Phenothiazine is one of the products that is turning out to be of great value in reducing losses—in this case, those caused by parasites in livestock, particularly sheep. It is a sulfur compound which turned up in the course of research begun as far back as 1928 in the effort of entomologists to find non-poisonous insecticides for spraying fruit. Ten years later it was tested as a killer of internal parasites in animals, and it turned out to be the most useful weapon in the whole arsenal of anthelmintics. Thus it came along just in time to play a part in the war.

Most anthelmintics are highly selective; they kill one parasite or group of parasites in one kind of animal. Phenothiazine, on the other hand, can be used against several different parasites in several kinds of animals. It is not so potentially harmful as many other anthelmintics, some of which must be used with great care to avoid violent effects. Finally, it can be administered with more ease than many other anthelmintics. It need not necessarily be given as a drench or administered as a capsule but can be mixed with the feed, or, in the case of sheep, with the salt the animals habitually lick.

Sheep are among the most parasitized of

all classes of livestock, and by the same token parasites are the sheepman's worst problem. After licking salt containing 10 percent of phenothiazine for about a month, a sheep is relatively free of the worms that do the greatest harm. Thriftier animals, more wool, more meat, and sounder intestines result from this treatment. The last point is peculiarly important in wartime. Sheep intestines are the source of the "catgut" used for sewing up wounds. Nodular worms ruin the intestines for this purpose by peppering them with small, gritty lumps.

Much progress has been made recently in combating some troublesome livestock diseases and in breeding disease-resistant plants. Notable in the latter field is the Pan-American tomato (resistant to fusarium wilt), wilt-resistant strains of alfalfa, and rust-resistant oats.

Shortages of Foods and Feeds

Fortunately, the period between the first and second world wars was extraordinarily rich in contributions to our knowledge of nutrition, so that we are able to meet the gigantic food problems of this war with a fund of scientific information never before available. To this knowledge, developed in the inter-war period, USDA nutritionists contributed a good deal, especially in techniques for measuring the nutritional quality of the diets of families and populations, and for translating such nutritive elements as proteins, minerals, and vitamins into practical food budgets usable by an individual or a family, or, on a larger scale, by the production planners. Hence these nutritionists are constantly called on for fundamental assistance in food planning during the war.

Some of their recent studies, for example, showed that during 1940, 1941, and 1942 the average civilian in the United States had a better diet, judged by content of calories, protein, fat, minerals, and vitamins, than during the pre-war years, 1935–39. During 1943, according to these analyses, the levels for proteins, minerals, and vitamins were about the same as in 1941 and 1942, except for thiamine, which was markedly higher. Thus, a scientific appraisal indicates that in spite of heavy war demands on our food supply, the over-all picture for civilians is not dark; in fact, some of the shifts in food habits necessitated by the war have improved our diets nutritionally. In particular, the average diet is richer in four important nutrients—calcium, niacin, thiamine, and riboflavin—than it was in the five pre-war years.

Among the shifts necessitated by war is a lesser dependence on meat as a source of protein, partly because the armed services need large quantities of meat, partly because livestock necessarily compete to some extent with human beings for the existing food supply. In general, the poorer a country is, the less it can afford to feed and eat animals or animal products and the more it must depend on foods produced directly from the soil. Since war makes all countries relatively poorer, the trend during war, whether we like it or not, is inevitably toward a less varied diet, with greater dependence on plant products, particularly grains.

Along with proteins of animal products, the proteins of legumes and nuts are of the greatest nutritive value to human beings; and among these, the proteins of soybeans stand particularly high, probably, according to recent research, because they include sizable amounts of certain amino acids needed by the body and adequately supplied by animal proteins. When the supply of meat must be made to stretch, therefore, it is worth-while to have soybeans to fall back on. Fortunately, to meet the demand for oil during the war, this country has become the world's greatest producer of soybeans, as noted later in this article. Crushing these soybeans for oil leaves enormous quantities of press cake which can readily be converted into either livestock feed or human food. Last fall, large amounts of soya flour and grits appeared for the first time on the American market as human food. To most Americans these were new food products.

Preceding this development, ARA nutritionists made careful studies of the nutritive value of soybean flour and also of two other possible high-protein flours, made from peanuts and from cottonseed. All three gave remarkably good results as measured by their ability to promote growth in albino rats. The experiments showed also that the

proteins in these products admirably supplement those in wheat. In addition, soybeans are a good source of other nutrients.

Since most Americans will be unfamiliar with the use of soya flour and grits in cooking, recipes for a variety of dishes from soup to dessert were worked out and carefully tested by the home economists.

Shortages of Other Agricultural Products

Developing Natural Sources of Rubber. For many years USDA plant explorers and plant breeders have done a certain amount of investigating and experimenting with rubber plants suitable for the Western Hemisphere and have emphasized the need for investigations on a larger scale. War events proved the wisdom of this pioneering work and brought an immediate amplification of it.

The hevea tree is native to South America, but attempts to grow it there failed largely because of a devastating leaf disease. USDA scientists discovered resistant strains, which were subsequently propagated and selected for superior yield. Some of these strains furnished the nucleus for the present plantation rubber program, carried on under cooperative agreements with fifteen Latin-American republics. At sixteen field stations, superior planting material is propagated and distributed, demonstration plantings are used to teach growers modern methods, agronomic and pathological investigations are conducted, and enormous quantities of seed collected from wild trees in the Amazon region, often in nearly inaccessible areas, are tested for further improvement. At the Ford plantation in Brazil and elsewhere, work is carried on in the making of carefully controlled crosses between trees of Far Eastern parentage and native stock. During the past two years some 25 million seeds were planted in nurseries from Mexico to Brazil for seedlings on which to graft superior, high-yielding strains. A beginning has been made in the development of producing plantations. But hevea trees take at least six or seven years to come into commercial bearing; hence quicker sources of natural rubber are being fully investigated.

The Mexican shrub, guayule, is usually harvested in four or five years, but when grown under irrigation it can be harvested in two years if the need for rubber is great. This plant has been studied to some extent by USDA scientists for two decades in connection with experimentation by a private company. Early in 1942 the Forest Service started large-scale experimental plantings, with ARA bureaus furnishing the research background and assistance. The work has involved studies to determine soil needs; pathological and entomological investigations; the development of suitable planting, cultivating, and seed- and plant-harvesting machinery; testing of strains with possible superior survival value in arid regions; and the development of efficient methods for extracting the rubber from the plant.

The list of plants that contain rubber in small or comparatively small quantities is considerable. Some give a harvest the first or second year, but each has its headaches in the form of poor yield or poor quality of rubber or difficulty in extracting the rubber. Several of the most promising, including goldenrod and kok-saghyz, have been under intensive study by ARA researchers.

In the case of most rubber-bearing plants, the problem involves a concerted attack by horticulturists, breeders, cytologists, pathologists, entomologists, soil scientists, chemists, engineers, and others.

Synthetic Polymers from Agricultural Sources. Meanwhile work has been pressed on the development of processes for making synthetic rubber and rubber substitutes from agricultural products. Information on two of these processes has been made public. One uses butylene glycol, produced from grain by fermentation, and the other fatty acids from oil-bearing seeds. Both processes were developed by the Northern Regional Research Laboratory.

The butylene glycol process is in effect something of a short-cut as compared with the production of rubber from alcohol as the basic material. In both cases, the basic material is converted into butadiene, from which Buna-type rubber is made by polymerization. Butylene glycol also has potential uses as an anti-freeze and in commercial solvents.

The oil process uses corn, soybeans, or

other products as source material and consists in polymerizing one of the fatty acids to produce a rubberlike substance. Other fractions of the oil are left as usable by-products. The USDA product has been called Norepol (from NOrthern REgional POLymer), but commercial firms adapting the process have given their products trade names of their own. Several companies are now making the rubberlike polymers which have characteristics enabling them to replace rubber for a number of uses, including tubing, shoe heels, plumbing gaskets, waterproof fabrics, and adhesives.

The butylene glycol and the Norepol projects illustrate the value of the pilot-plant method now being used extensively in ARA research. The perfecting of a process at the laboratory table tells little about its practical value; all kinds of difficulties, great and small, can develop in commercial production. To discover and eliminate them as quickly as possible, a large-scale laboratory simulating commercial conditions—in other words, a pilot plant—is invaluable. Pilot plants for a number of different kinds of processes are in operation at the four regional laboratories. In addition, close cooperative relations have been built up with industry. As soon as a new process or product has reached the point where it looks really promising, commercial producers are invited to cooperate in further research and development. This greatly widens the personnel and facilities that can be focused on the problem and its solution. It is not too much to say that in some recent cases several years' work has been shortened to as many months by well-organized cooperation in research and the early use of the pilot-plant technique.

Growing Our Own Fibers and Oils. Among the major products of agricultural origin that have had to be produced in vastly increased quantities in this country, usually because foreign sources of supply were cut off, are fibers and oils. In some cases, the crops involved have previously been grown in the United States only to a very limited extent, if at all. Thousands of farmers, who have turned to growing one or another of these crops for the first time, had to be shown how. Seed had to be increased rapidly for large-scale production; in some cases there were no commercial supplies of seed. Suitable soils had to be selected. Climatic requirements, cultural needs, disease and insect control, harvesting and processing methods and machinery—all these present problems that must be solved quickly, with a minimum of failures and mistakes, in the case of a new crop urgently needed for war.

In most cases, the research workers already had a stockpile of information that could be put to use at once; even though a crop is not commonly grown in the United States, it is sometimes studied experimentally on a small scale for one purpose or another. It was also possible in some cases to round up experimental stocks of seed and increase them rapidly enough for fairly large-scale planting in a year or two. Needless to say, efforts have been made to fill the holes in our knowledge of these crops and products by intensive research projects designed to develop the needed information as quickly as possible.

When foreign supplies of abacá, sisal, and jute were cut off, plans were immediately made to grow immensely increased amounts of hemp in this country as a partial substitute for these fibers, used for bagging, twines, and cordage. Locations for hemp growing were determined; seed production was stepped up 3,500 percent in 1942; by 1943 there was enough seed for some 200,000 acres, to be planted by farmers who for the most part had never grown hemp before. Meanwhile experiments had gone forward to develop improvements in seed treatment, cultural practices, retting, storage, and other aspects of hemp production.

In the making of marine and other strong, durable cordage, hemp cannot substitute satisfactorily for abacá, or so-called Manila hemp, produced chiefly in the Philippines and formerly imported into the United States to the extent of 100 million pounds a year. As far back as 1925, USDA plantmen began experimenting with selected varieties of abacá in Panama, so that in 1942 they were ready to undertake an immediate large expansion in acreage. Today, some 30,000 acres are being grown in tropical America through cooperative arrangements with Panama, Costa Rica, Guatemala, and Honduras. Increased production of other hard fibers in

Latin American countries is also being actively encouraged.

War immediately focused the spotlight on oilseed crops in the United States by cutting off huge supplies of imported fats and oils and making it necessary for us not only to replace them but to furnish additional huge supplies to our allies.

In the case of soybeans, one of the chief potential sources, the groundwork had already been laid for a greatly expanded production. More than 2,500 types of soybeans were brought to this country from the Orient in the 1920's and 1930's, largely through the explorations of Morse and Dorsett of the USDA; and breeding work in cooperation with the States has been going on actively. The growth of soybean production in this country has been phenomenal—from about 5 million bushels in 1924 to 210 million in 1942 and a still larger acreage in 1943. The United States has now become the world's leading soybean producer, topping even Manchuria, famous as the Land of the Bean.

The jump in production during the last two years, needless to say, has meant a large amount of work for USDA and State plantmen qualified to furnish scientific information for growers, especially those to whom the crop is new. In addition, the research program has been stepped up and, in the South especially, considerably extended. New varieties with higher seed yield, increased oil content, better quality of oil, and good regional adaptation have been tested simultaneously in many locations and introduced as soon as they proved their superior value. Incidentally, it is worth noting that the accelerated adoption of technological advances by farmers in the United States may be a major outcome of the war, and one of great significance, since the chief hope for

U.S.D.A. Photograph by Forsythe

SECRETARY WICKARD AND DR. MOHLER EXAMINE A COW UNDER TREATMENT AT THE ANIMAL DISEASE STATION OF THE U. S. DEPARTMENT OF AGRICULTURE AT BELTSVILLE, MARYLAND.

GUAYULE PLANTS GROWING IN GREENHOUSE

U. S. HORTICULTURAL STATION, BELTSVILLE, MD., WHERE REQUIREMENTS FOR GROWTH HAVE BEEN STUDIED.

an expanded and flexible agricultural production in the future lies in technology.

Help for Consumers at Home

A good example of direct assistance to the public by scientists is the Victory Garden campaign. Not only farmers but suburban and city people had gardens last year, many of them for the first time in their lives; and they naturally looked to the experts, Federal and State, for help. Help was given to the limit of facilities. A Victory Garden bulletin prepared by a USDA plant scientist was in demand to the extent of more than 3 million copies; other printed material on fruit growing and on insect control was widely distributed; and weekly radio programs on gardening reached a large audience, one program alone bringing close to 8,000 requests for answers to specific questions that were troubling gardeners.

The greatest demand from the general public, however, is in the broad field known as home economics. With food rationing, for instance, housewives have faced many new problems in managing food budgets and feeding their families adequately. They had to take shifting food supplies in their stride, going without this, substituting that, and taking more care to prevent waste of all kinds than most of us ever thought possible. And this situation not only applies to food; great numbers of items ordinarily used by civilians, including clothing and household equipment, are scarce. Conserving, mending, patching, making over, substituting, and doing without are words that have a meaning never before realized for millions of Americans.

How to cut down consumption of meats and fats and still have nourishing, tasty meals; how to can foods safely; how to de-

DELOUSING THE NEW WAY
A SOLDIER DUSTS HIS CLOTHING WITH LOUSE POWDER DEVELOPED BY THE U. S. DEPARTMENT OF AGRICULTURE.

hydrate foods at home, often with homemade equipment; how to cook with a minimum of loss of vitamins and minerals; how to mend clothes as neatly as our grandmothers did; how to repair a man's suit like a professional tailor, or perhaps convert it into a natty outfit for a woman; how to repair or condition a sewing machine as well as a mechanic could do it; how to make the old refrigerator, washing machine, or electric range survive to a ripe age without breaking down—these are a few of the many questions with which ARA home economists are deluged from day to day during the war. And the public looks to them, not for any answer, but for the right answer, for information that can be used with confidence because it is backed by experience and experiment.

The home economists are drawing on everything they have done in these and other fields, and interpreting it in relation to war needs. Last year the public distribution of their bulletins, leaflets, and other printed material reached a total of 27 million copies —an indication of the extent of the demand for help on the part of the public. In addition, they are developing new research in nutrition, food preparation, textiles, clothing, and household equipment to meet war situations.

Demands of the Armed Services and Other Agencies

The Battle of Bugs. ARA has cooperative arrangements to carry on research for the medical branches of the Army and Navy, the Quartermaster General's Office of the Army, the Bureau of Supplies and Accounts of the Navy, and the War Food Administration; and requests come in from many other Government agencies also.

One of the early challenges was to develop a better means of killing lice, in clothing and on bodies, than the slow, antiquated methods hitherto in use. Specifications were set up for what was wanted, but the military authorities were frankly skeptical that it could be done. It was done by USDA entomologists in about three months' time, largely because of the stockpile of information assembled during many years of research with pests of livestock and crops. A soldier's clothing can now be freed of lice in a few minutes, even at the front, by the use of a fumigant, without the old cumbersome equipment. His body can be kept free of lice by the use of a powder, without the old mass delousing procedures. Lice are carriers of epidemic typhus, trench fever, and relapsing fever; hence this development is a lifesaver as well as a contributor to comfort.

Some of the other major insect enemies of man are in for rude shocks when the war is over and civilians can get materials now used exclusively by the armed services.

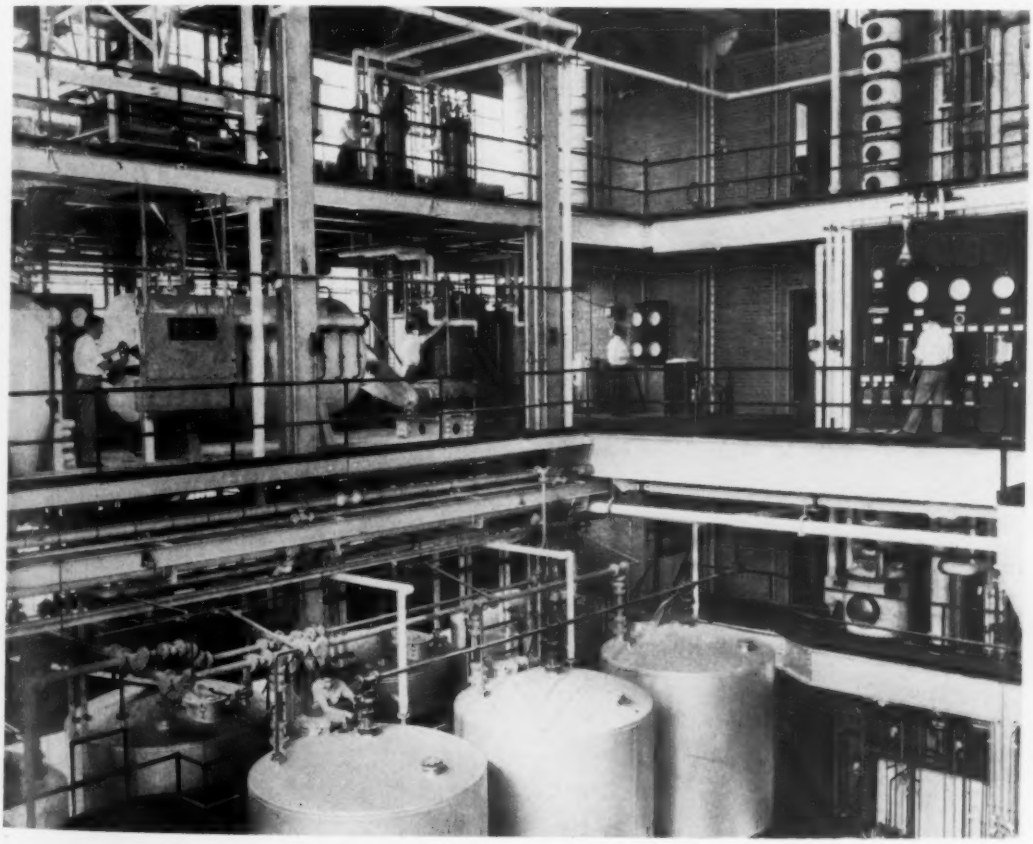
USDA entomologists have developed a method of killing mosquitoes, flies, and other insects in closed spaces—a tent, a room, a barn, a greenhouse—which is more effective and convenient than the old-time sprays.

An insecticide, an activator, and a volatile solvent are mixed and sealed in a small metal container, called a "bomb" because of its appearance. When a valve is opened briefly by thumb pressure, an infinitely fine mist is shot out by the pressure of the volatile solvent which evaporates immediately, leaving the infinitesimal particles of the insecticide floating in the air. They quickly spread everywhere, like an invisible fog. One puff, containing as little as a milligram of the

insecticide, will kill every mosquito in a thousand cubic feet of space within five minutes. And mosquitoes, of course, carry yellow fever and malaria. Immense numbers of these lifesaving bombs have been manufactured and sent to fighting fronts.

Compact Foods. The war brought an urgent demand for research in dehydrating foods, for reasons that are obvious—shortage of shipping space; shortage of tin; the need for compact, readily transported food that would remain wholesome under all conditions without refrigeration. Dried foods are not new. Probably every nomadic people has used them. But this time greater quantities of a greater variety of dehydrated foods were needed than ever before, and they had to meet standards set by modern advances in food technology and the science of nutrition.

A third of the Western Regional Research Laboratory at Albany, Calif., was turned into a huge pilot plant to dehydrate vegetables on a semi-commercial scale. Some of the research personnel at this laboratory had pioneered in dehydration years before and had a background of experience. Fairly early in the new program they were able to draw up specifications for several of the more common dehydrated vegetables, as well as blueprints for commercial dehydration plants of various capacities. Two dehydration short courses, one in the West and one in the East, were given for commercial plant personnel, followed by another short course for State Experiment Station personnel, who were being deluged with requests for advice and assistance. In a short time a mass of technical data covering almost every aspect of the commercial dehydration of vegetables



U.S.D.A. Photograph by Forsythe

PILOT PLANT, PEORIA, ILLINOIS

SET UP AT THE NORTHERN REGIONAL RESEARCH LABORATORY OF THE U. S. DEPARTMENT OF AGRICULTURE TO TEST ON A SEMI-COMMERCIAL SCALE NEW PROCESSES FOR MAKING ALCOHOL FROM VARIOUS FARM PRODUCTS.

began coming out of this laboratory, to be made immediately available to the industry through technical journals, mimeographed sheets, and otherwise; much of it will soon be published in a bulky dehydration manual. Additional information came from the Plant Industry Station at Beltsville, Md., where methodical studies have been made of the suitability for dehydration of different varieties of vegetables and fruits grown there and elsewhere.

In a word, as solid a technical foundation as could be built in so short a period has been furnished the new industry. The job is not finished. New research is under way, for example, on the compression of dehydrated foods to achieve further space saving.

Meanwhile, work on the commercial dehydration of meat was started at the Beltsville Research Center early in 1942. Livestock specialists, meat specialists, engineers, chemists, bacteriologists, nutritionists, and home economists were drawn in to make a coordinated attack on the problem and to get usable results and a safe, wholesome product as quickly as possible. Within a few months, specifications were drawn up for dehydrated beef and the first commercial bid was asked for by the Government. Pork followed a short time later.

Among other ARA activities in dehydration have been the inspection of egg-drying plants and improvements of the product; improvement in the packaging of whole milk powder, to overcome the difficult problem of oxidation of the fat in the milk; and, very recently, the development of a new method of dehydrating whole-milk cheddar cheese, which gives a superior product, easily shipped and handled, and with all the quality of the natural cheese.

This brief account covers only the work of the Agricultural Research Administration and only a little of that. Other agencies, the Forest Service, the Soil Conservation Service, and the Tennessee Valley Authority, for example, have also been engaged in agricultural research during the war; and the State experiment stations in particular have contributed a mass of information on the problems of producers and consumers in their areas.

Much of this work, needless to say, will have a marked effect on production practices and on consumer products after the war, when we are ready once more to turn swords into plowshares; but just what the effects will be, and how extensive, the scientist usually prefers not to guess. In the first place, too many economic and social factors that he cannot fully evaluate are involved. In the second place, he has been too immersed in urgent war problems to think much as yet about those of the post-war period. We badly needed such things as dehydrated foods, synthetic rubber, and soybean oil. Research made it possible to have them. The same research will be called on to meet vital post-war needs, and it will be ready.

PICKLE HELICTITES

By RAYMOND E. JANSSEN

In geology "helictite" is the name given to a curious twisted form of stalactite. The growth of helictites in caverns is an intriguing subject of recent investigation among geologists, and experiments in producing them artificially in the laboratory have been made; for example, by Lyman C. Huff (*Journal of Geology*, 48: 641–659, 1940). Closely resembling helictites in appearance are some curious growths which I observed and photographed on the jar lids of several bottles of home-canned pickles stored in the basement of my mother-in-law's home. Like helictites, these show irregular growth patterns; but instead of growing downward or laterally from suspension, they grew upward. Also, these growths seem to occur both in a crystalline and in an amorphous structure. The crystalline forms are solid or spongy and are extremely delicate (Fig. 1), and the amorphous forms are more or less hollow and considerably more sturdy (Figs. 3 and 4). Both forms may occur in close association on the same lid (Fig. 2).

The first growth of this nature was discovered by my mother-in-law one day when she went to her basement for some jars of her canned goods. While visiting at her home, my attention was called to the strange growth. I photographed the specimen first and then, upon examining it, I found that the growth had its start in a minute pinhole which had developed near the top of the zinc jar lid. Apparently the hole had been eaten in the lid as a result of chemical reactions which had taken place within the jar during the months since the pickles had been canned.

There are two possible causes for such chemical reactions in the pickle brine. First, the jar may not have been perfectly clean or impurities may have gotten into the brine at

FIG. 1. CRYSTALLINE HELICTITES
DELICATE FORMS EMERGING FROM PIN-HOLES IN LID.

FIG. 2. TWO FORMS OF HELICTITES
CRYSTALLINE AND AMORPHOUS ON THE SAME LID.

the time of canning. Second, the jar lid may not have been secured tightly or may later have been disturbed so that air was able to enter subsequent to canning. If the latter was the case, the jar must later have become resealed in order to permit gas pressure (evidenced by the bulged lid) to have been built up inside after the chemical reactions began. The latter seems more likely for two reasons: First, all of the jars of this canning batch were not affected. Second, a white carbonate precipitate was formed inside the jar, filling the space around the threads of the lid. This area, of course, is the place where resealing would have to occur in order to make the jar airtight.

The corrosive brine within the jar may have come into contact with the underside of the zinc jar lid in one or more of three ways: first, by bubbling of the liquid during reaction; second, by capillarity of the liquid upward along the inside of the jar and lid; third, by splashing the inside of the lid at the time of canning or by condensation of water vapor on it later, either event providing a wet surface for the solution of acid gases or vapors. Contact of this liquid with the zinc produced zinc acetate and zinc carbonate, of which the strange, helictite-like growths and other precipitated material on the outside and inside of the lid were composed.

Whether these "stalks" grew from their tips or by accumulation and upward pushing from their bases is not known because the reactions which caused them had apparently stopped before they were observed. If they grew from their tips, capillarity along the entire length of their stalks must have been responsible. There is some suggestion, however, that they might have grown from their bases. When the pinhole first opened, the gas under pressure beneath the lid must have escaped, and may have driven a solution of zinc salts through the hole and left a droplet to evaporate above the hole. The residual solids may have sealed the hole, thus permitting gas pressure to build up again under the lid. If, then, the pressure became sufficient to break the seal, more solution may have been carried up through the pinhole and left under the first plug of zinc salts. Upon evaporation the resulting plug might have carried the first plug on top of it. Repeated, alternate sealing of the hole and eruption of gas might have thus built up the solid, crystalline helictites.

The irregular, zig-zag pattern of the solid stalks, which could have been caused by unbalanced deposition of solutions, are best explained by assuming the occurrence of successive eruptions of gas. The development of these helictites might be likened to the growth of the chemical "snakes" which children set off among their Fourth of July pyrotechnics. Also, the material making up the "tufts" at the tips of the stalks is similar in form and composition to that which is incrusted on the jar lid, indicating that it may have been formed first and then may have been carried upward at the tip while the stalk grew in length from below. This general incrustation around the outside bottom of the jar lid is not uncommon on jars of home-canned pickles, and seems to form as a sort of "frost." In certain jars liquid oozed past the rubber washer, dribbled down the outside of the glass, and left a streak of precipitate all the way down the outside of the jar. In some cases, such precipitate is known to have formed before the formation of the helictite-like growths.

Several months after the first helictite-like specimen was discovered, similar growths were found to have appeared on several other jars belonging to the same batch of pickles. All these growths occurred on jars which had been canned during the summer of 1937. These jars had then been placed on a shelf about six inches above the floor in a cool, dark, damp corner of the basement. Most of their contents were consumed by the family within the next season or two, but several jars remained untouched until February, 1940, when the first growth was observed and photographed (Fig. 1). At that time there was no indication that any of the other jars of pickles was in the process of spoiling; hence they were allowed to remain on the shelf. It was not until August 30, 1941, that the growths shown in Figures 2 and 3 were discovered. Since these growths were not anticipated, no observations of the jars had been made during the interval; hence it is not known how much time was required for the growths to attain their pictured state of

FIG. 3. TUBULAR AMORPHOUS TYPE

FIG. 4. NINE MONTHS LATER

development. That they attained their growth solely within the period from February, 1940, to August, 1941, however, is established.

One of the most interesting of these growths is the tubular form shown in Figure 3, together with the secondary spine which later emerged from within the tube (Fig. 4). In miniature, this primary growth was not unlike the formations which are built up around the surface openings of geysers and hot springs. This specimen was first observed and photographed on August 31, 1941. It was then replaced in the same position on its shelf in the basement, and again observed and photographed on May 31, 1942, at which time the secondary growth, approximately 1½ inches long, had emerged from the hollow of the original growth. Unfortunately, this secondary spine was not observed until after growth had stopped.

The materials that gave rise to these curious, helictite-like growths included vinegar, salt, sugar, mustard seed, celery seed, and onions in addition to the cucumbers. The canning was done hot, and the jars were filled up to the brim with brine.

The close resemblance of these growths to cavern helictites may, or may not, be significant. The conditions that existed in the dark, damp, slightly drafty basement where they grew were not vastly unlike those prevailing in a cavern. So far as known, such growths have not heretofore been reported. Because of their remarkable similarity in appearance to some helictites, I have chosen to call them by the absurdly appropriate name of "pickle helictites."

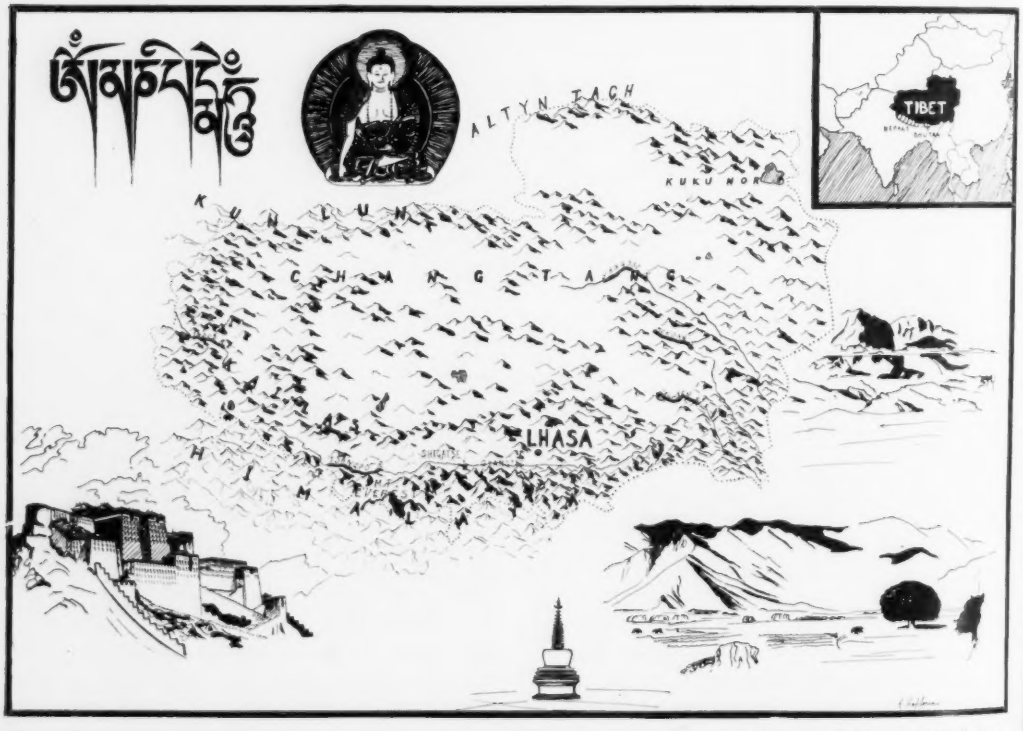
THE FORBIDDEN LAND

By MARY ELLEN GOODMAN

In the days when the cautious, and perhaps very wise, Chinese induced the Dalai Lama to close his country to the "White Devils," Tibet became to Europe a legendary forbidden land. Those incautious souls who defied its regulations and dared its rigors found it no less forbidding than forbidden. From the Himalaya and the Karakoram on the south and west to the Kun-Lun, Akka-Tagh, and Altyn-Tagh on the north, the Tibetan borders are defended by the world's most formidable mountain ranges. Across these vast heights, tremendous open plains, and treeless valleys sweeps a howling wind from mid-morning until sunset. During perhaps four months of the year the milder parts of Tibet are free from frost. Between October and May there is very little precipitation, but in July and August there are occasional violent thunderstorms, particularly on the western highlands and northern plains. Hence the chief supply of water comes from the fairly numerous rivers fed by melting snows. Springs are rare and usually thermal and sulfurous; the lakes, while numerous and sometimes very extensive, are often brackish. "Natural" trees occur but rarely, save in the extreme south and east of Tibet. Elsewhere the barren, stony or icy reaches produce only a few stunted bushes, a rare willow or cottonwood, coarse grass and, in the higher altitudes, moss. The natural fauna—sheep, bharal, gazelle, wild ass, wild yak and even the domestic yak—subsists mainly upon the moss.

Of Tibet's 700,000 square miles, six-sevenths are estimated to be uninhabitable. Its population of three to four millions, few of whom probably reside at an altitude below 10,000 feet, is concentrated in the southern and eastern portions of the country (Fig. 1).

The northern plain, the Chang Tang, is



Drawing by Virginia Hefferman

FIG. 1. TIBET—THE FORBIDDEN LAND

peopled only at its southern border. Elevated to 16,000 feet and more, it produces no crops or trees, and boasts little of value to man save salt lakes rich in potash, borax, and soda.

In the river valleys of southern Tibet are the cities and converging "highways," the farms and the better pastures. This area falls away to a mere 10,000 feet, and woods and the less hardy crops flourish. In south central Tibet lie the three principal cities: Shigatse, Gyangtse, and Lhasa.

Eastern Tibet, deeply carved by great river valleys, slopes to 6,000 feet. Here is the most fertile part of Tibet. Such trees as willows, poplars, and cottonwoods are planted and cherished in walled parks. In private gardens walnuts, apricots, peaches, apples, bamboo, cypresses, and pines are grown. Except for the walnuts, the fruit borne is small and poor. Vegetables such as cabbages, peas, beans, potatoes, turnips, and radishes are here produced, as well as a variety of imported garden flowers. Forests, water, good grazing, and mineral wealth are more abundantly available than elsewhere in this elevated land.

As to the people themselves, they are believed to have come originally from the northeast, from the vicinity of Kuku Nor. These early Tibetans were doubtless pure pastoralists, and of a physical type still best represented among the pastoral tribes (Fig. 2). The sedentary peoples show Chinese admixture in increasing concentration toward China, and Nepalese, or Kashmiri toward the southwest. The "primitive" type is probably the short, brachycephalic Mongoloid, though dolichocephals are frequently observed, particularly among the upper classes and the priesthood.

Native tradition ascribes Tibetan ethnic origin to an ape-god and a female demon, and the flood motif is not lacking. According to Chinese tradition, the early Tibetans were an inferior people driven out of China to the vicinity of Kuku Nor in the twenty-third century B.C. Tibetans attribute many of their more complex culture traits to their traditional first king, who came from India in the first century B.C. The Tibetan alphabet is said to be based on the Indian as used

FIG. 2. NOMAD IN MARKET PLACE*
IN TYPICAL TIBETAN FASHION HE BARES HIS RIGHT SHOULDER DURING THE WARMER HOURS OF THE DAY.

in Kashmir, while the major linguistic affinity of Tibet is with Burma. The complication of Tibetan culture above the postulated original pastoralism may be attributed largely to borrowings from China and India, the former being the chief source of material culture.

The modern line of Tibetan "priest-kings" was begun in 1270 by decree of the Great Khan, who, having been converted by the high priest of a large Tibetan monastery, indicated his approval of this gentleman and his good works by turning over to him the sovereignty of his country. Three or four centuries earlier the Tibetan nobles had adopted Chinese silk garments, surrounded themselves with Chinese scholars, sent their children to study the classical literature of

* All photographs are reproduced by courtesy of the Peabody Museum, Harvard University.

China, and had workmen brought from Singan to make paper and ink. In the eighth century they had threatened the power of China itself, but their kingdom became dismembered by civil wars as a result of the conflict between civil and priestly powers. Then followed a period of persecution of the religious leaders, during which Buddhism was suppressed for some seventy years, only to rise triumphantly with the support of Kublai Khan, and China has since not ceased to support the "clergy." The finger of Chinese political influence has never been entirely absent from Tibetan affairs, though a marked diminution of the pressure took place with the ascendancy of the star of British political fortunes in this area, and with the 1911 revolution in China.

European influence has brought into Tibet (most particularly in Lhasa) such cultural innovations as kerosene lamps, an electric plant and its limited use for lighting, a wireless transmission set, a postal and telegraph system, soap, tooth brushes, silver tea sets, the gramophone, and a slight tendency among the gentry to observe European social habits.

FIG. 4. TOWNSMAN IN WOOLEN GOWN
HOLDING A PRAYER TRUMPET AND A PRAYER WHEEL.

FIG. 3. PEASANTS IN SHEEPSKIN GOWNS
WOOL TURNED INWARD. ONE WHIRLS A PRAYER WHEEL.

These innovations are, however, extremely limited in scope. Tibetans in general have apparently changed their ways but little since the major revolutions induced in their lives by the introduction of tea and of Buddhism, of which the former was perhaps the more revolutionary.

As to economy, there is to be found among Tibetans a range between near-subsistence nomadism and highly-developed business enterprise involving full-time traders, financial experts, and the basic principles of European commerce.

From the viewpoint of modes of subsistence, Tibet divides itself into the region of tents and that of houses. This division rests primarily upon geographic and climatic factors, tents being pre-eminently the dwellings of the nomad herdsmen, though some few of the latter live in houses. Toward the south and east, in regions suitable for agriculture, tents mingle with stone houses and are gradually entirely displaced thereby. Semi-

commercial economy prevails in both spheres, however, the herdsman exchanging his surplus commodities for those of the peasant, without which he could scarcely survive, and both depending to some degree upon imported articles, especially tea. The peasant household may be expanded to the scope of the feudal estate, on which the farmer exchanges a part of his labor for commodities, but the economic unit is in any case essentially the domestic one. Even manufacture for export, as of Tibetan carpets, takes place within the feudal household.

Pastoralism having been identified with the tent, a survey of this mode of subsistence might well begin with a closer inspection of this shelter. It is fabricated by the Drok-pa and his family, and, by its durability, portability, and wind resistance, is excellently adapted to his mode of life. The Tibetan tent is of black yak-hair fabric in two pieces brought together at a horizontal ridge-pole. Between these an aperture is left for ventilation and the escape of smoke. The ridge-pole is supported by a pole at either end; the cover is tightly stretched by cords fastened to the sides and corners, which are passed over short poles some distance from the tent and firmly pegged down. The lower edge, too, is held down by iron pins or animal horns. The tent may be twelve to fifty feet in length, housing usually five or more persons; and is rectangular in shape. About it a wall of mud, stone, or dung serves as protection against wind and snow, as a convenient fuel supply, or as protection against brigandage. In places of longer occupancy the walls of the shelter may be of sod or stone with a felt roof, while temporary wall shelters may be built up of whatever materials are at hand—perhaps the bales of wool being transported to market—and left open to the sky.

In the center or near the entrance of the tent will be found a stove-like structure of mud or stones on which a brass kettle or two will be set over a dung fire. Along the walls, or stacked to form recesses, are cooking utensils, buckets and churns, rugs, strips of felt and blankets for bedding, saddles, and leather bags containing food. Pails of milk, cream, curds and cheese stand about, and perhaps a basket of tea leaves once used and saved for another service, as well as a collection of bones, one bone from each animal eaten having been preserved. At the back of the tent is the "cupboard of the gods" before which lies a large block of wood which constitutes the place of honor in the house. At this shrine a butter-lamp burns to the "Great Name."

The peasant is sheltered by a flat-roofed structure of stone slabs held together with mud, or of sun-dried bricks. These windproof walls have only few and very small windows, if any. The better homes boast wax cloth, paper or, rarely, imported glass in the windows. In any case the windows are nearly always covered with wooden shutters. The homes of the poor have a yard at the front or back, but the houses of the prosperous are arranged around an inner court and may boast several stories. In the latter case the ground floor may be completely covered and serve as a stable and storehouse, while on the first or second floor will be a verandah, consisting merely of a room of which the outer wall has been removed.

FIG. 5. TIBETAN LAMA
WEARING THE PEAKED HAT OF HIS PARTICULAR SECT.

Access to upper stories is gained from the courtyard by rough stone steps, a ladder, or a notched log. The roof is of beaten earth or, in forested areas, of long, pine shingles weighted with stones. In large rooms wooden pillars, sometimes carved and painted, will be used as interior roof supports. The roof is a functional part of the Tibetan home: there will be found prayer flags, a pot of incense, firewood, drying pots, perhaps onions growing in boxes, and a chained watchdog. No bolts or nails are used, and as Bell states in *The People of Tibet*, "dovetailing is an art which is thoroughly understood." Floors are of small pebbles and earth beaten down and polished with oil, or of roughly smoothed planks. A tendency toward colorful architectural embellishment is notable in the decoration of the great wooden gate by which ingress to the more pretentious homes is usually gained. This gate may be beautifully carved and brightly painted, perhaps with the swastika significant of durability, or the traditional "Mongol Leading Tiger" scene for luck.

Furnishings of the homes of the well-to-do farmers will include a few small tables, heavy wooden chests arranged along the walls and some mattresses stuffed with wool or straw and bound in cloth. Every home of any pretensions must have a "religion room." In the house of the farmer it will contain his better clothes, the ornaments of his women, and other valuables stored in chests or cupboards, some images, and butter lamps. The homes of the wealthy may contain two or more such rooms, elaborately furnished with ritual objects, art objects, sacred books, and so on; the walls and ceilings may be covered with cotton cloths or Chinese brocades, while the floors will be thickly carpeted with woolen blankets, Tibetan rugs, and large pieces of felt. Art and religious objects, often of Chinese workmanship or inspiration, predominate among the furnishings of the better homes. Functional furnishings are apparently rather few.

The house of the farmer, like the tent of the nomad, is likely to be situated on high and sloping ground. The great city mansions may be on the level plain, however, and are usually surrounded by a grass-carpeted park in which a few trees are cherished. Here may be a little "pleasure house" which becomes the center for outdoor entertaining, especially during the summer.

There is yet another class of structure: the great public buildings of the metropolitan centers. Greatest of these is the Potala, the monastery-palace of the Dalai Lamas. The lower walls of such buildings are of granite; the upper, of mud bricks partially surfaced with red-dyed mortar on which golden monograms and emblems may be effectively set. Interiors of public buildings are said to be disappointing. According to F. Spencer Chapman, "Dark passages, slippery with centuries of spilling of Tibetan buttered tea, lead with no apparent design from assembly hall to shrine, and from temple to private apartment." However, color is again to be found in the painted beams and pillars which support the ceilings. The arch is not used, and upon the square poplar pillars rest transverse willow poles laid a foot or more apart, and above these, smaller branches are laid at an angle, giving a pleasing herringbone effect. Above the branches is laid the flooring of the upper story.

As the forms of shelter reflect the diversity and complexity of Tibetan culture, so also, though to a somewhat lesser degree, do modes of dress and personal adornment. These are matters of considerable importance to both sexes, and are indicative of social and economic status, occupation, and locality. Brilliant colors and rich fabrics are preferred, with emphasis among the gentry upon imported Chinese silks, embroideries, and furs. The standard article of clothing, for both sexes and all classes, is a very full gown with a high collar and very long sleeves. Among the herdsmen of the north it is most likely to be made of unlined sheepskin (Fig. 3), perhaps adorned with edgings of panther skin or colored wool. Among the peasants it may be of yak hair or leather, and in the towns of blue or dark-red wool (Fig. 4), or of silk, perhaps fur-collared, while among the lamas it is colored red or yellow, depending upon the order to which the individual belongs. In summer this gown may be of native cloth or of imported silk; in the winter, of sheepskin or cloth lined with lambskin or wadded cotton, depending upon the re-

FIG. 6. A GROUP OF WOMEN WEARING THEIR HAIR IN THE TRADITIONAL 108 BRAIDS
THIS HAIRDRESS WAS SUGGESTED BY THE 108 VOLUMES OF THE "KANDYUR," THE TIBETAN BIBLE OR CANON.

sources of its wearer. Always it is tied tightly about the waist with a woolen, cotton, or elaborate silken band, and bloused above. The capacious "pocket" thus formed is likely to bulge with a collection of personal oddments. The robes of workers will be pulled up to the knee; those of the gentry, priests, and women will fall to the ankle. Beneath this gown may be worn a sleeveless shirt and perhaps a waistcoat of any of the available materials. Over the gown, in central and eastern Tibet, the women wear a broad, varicolored apron. The ceremonial dress of chief lamas and officials is more likely to be Chinese in both pattern and material.

Shoes are of two types: Chinese and native. The latter have "uppers" of Tibetan cloth, felt, or leather, usually varicolored and reaching to the knee. The soles are made of thick rope or raw yak skin. Chinese boots are of mid-calf height, with velvet tops and leather soles.

Headcoverings assume a great variety of shapes and types. In winter they are preferably furred, but felt is the material most widely used, with cloth a close second. The people of eastern and northeastern Tibet often go bareheaded, while the nomads may cover their heads and ears simply with a strip of sheepskin. On their shaven heads

FIG. 7. A TIBETAN LADY

FIG. 8. EXAMINING CHINESE BRICK-TEA

the lamas are likely to wear a peaked cap, variable as to size and color (Fig. 5).

Personal adornment of less functional nature goes chiefly to the head, particularly of women. The hair of nomadic women is decorated with three ornamented bands reaching nearly to the ground, or worn in the traditional 108 braids (Fig. 6). On the forehead may be worn a large jewelled disc. Sedentary women more often wear their hair twisted and twined through large and cumbersome wooden frames, or parted in the center and built out into a huge wedge on either side. Men, especially herdsmen, wear rings in their hair as well as an ornamented band fastened to the queue, which is worn wrapped around the head or hanging loose.

Finger-rings, charm-boxes, necklaces, and earrings are nearly universal (Fig. 7). A large silver ring or drop, set with semi-precious stones, is usually worn in the left ear, while a rough turquoise is worn in the right ear. The charm-box is a more or less elaborate and heavy affair worn suspended about the neck and containing script and pictures especially prepared by a lama for the warding off of colds, coughs, and other bodily ills.

The Tibetan, especially the nomad, usually carries in the pocket of his gown such accessories as a knife, a needlecase, a tobacco-box, a pipe, a cup, a powder-horn, and a tinder-box. In many districts it is no doubt both prudent and customary to carry about the person a weapon of some sort. While the bow is the traditional heavy weapon, the sling is apparently now in most common use among the poor. A straight, two-edged sword, perhaps a long rapier stuck through the belt, and a six-foot lance with an iron head and light shaft complete the armory.

"Man does not live by bread alone," but in Tibet, by all accounts, he might almost live by tea alone. Chinese tea, beaten up with butter and flavored with salt or soda, constitutes the staff of life for Tibetans, rich and humble (Figs. 8, 9). Their capacity for this beverage is apparently infinite; writers disagree only as to whether the consumption is thirty to forty or seventy cups a day. This tea is invariably black and inferior in qual-

FIG. 9. CHURNING BUTTER AND TEA

FIG. 10. THE YAK, MOST USEFUL ANIMAL OF TIBET

ity. Buttered tea, dry cheese, and the flesh of wild and domestic animals constitute the bulk of the food of the pastoral peoples. Their vegetable food consists mainly of a radishlike root, which is said to grow to altitudes of 14,500 feet, and barley and millet imported from the agricultural districts. Millet may be mixed with buttered tea and made into cakes called tsamba. Very little milk is drunk, and pork and poultry are used only in the agricultural regions.

To the prosperous in urban areas are available all the resources of the herdsman, hunter, and peasant, plus a not inconsiderable variety of imported foodstuffs. On an official visit in a wealthy Lhasa home, Chapman recounts having first been served, in the "main sitting room," with a preliminary meal of tea, dried fruits, sweets, and biscuits. Later the main meal was brought in: there were dishes of boiled mutton, yak tongues, preserved prawns, dried fruits, small nuts and sunflower seeds, sea slugs, sharks' fins, mushrooms, bamboo roots, meat balls, stuffed eggs, and quantities of barley beer. This food was in general highly seasoned and was eaten with chopsticks.

Butter is made from the milk of the sheep, the goat, the yak, the yak-cow hybrid, or the cow. That of the yak or hybrid animal is preferred. Butter is clarified and sterilized by boiling. The buttermilk is then boiled and the curd strained out, wrapped in cloth and pressed with heavy weights to further dehydrate and shape it. Later it is cut into cubes through which a yak-hair string is passed, and these cubes are hung up to dry. In this condition it can be kept indefinitely and provides an excellent source of nourishment for the traveller. The whey left over from this process is given to the calves or dogs and is sometimes utilized by the people. Food preservation is not a major problem. It is said that in the dry, cold air meat may be kept two to three years and grain two to three hundred years!

The fields of the Tibetans are usually in the protected valleys. They are small and rather poor, but fair yield is obtained since climatic conditions preclude the production of more than one crop per year, and crop rotation, fallowing, and fertilization are practised. Furthermore, some alluvium is deposited by the action of irrigation waters channeled off the streams and rivers.

Barley is pre-eminent among Tibetan

cereals and is the chief upland crop. Wheat, peas, mustard, buckwheat, maize (a staple in eastern Tibet), radishes, and turnips are other crops of main importance. Rain in May and June is essential to the crops; should it fail, the government supplies lamas to hold "Rain-Bringing Services." These dignitaries go to the sacred springs where there dwell beneath the ground the serpent spirits in whose charge are water, trees, crops, flowers, and treasures. At these spots they hold ceremonies. When permission has been given, by the Dalai Lama or other officials, harvesting may begin. This is a period of intensive labor when the entire family rises and goes to the fields an hour or two after midnight. There they labor until sunset or longer. Once the crops are in, a day is spared for feasting and celebration.

Threats to the crops are numerous and must be averted by both empirical and magical measures. Frost is the greatest enemy, and in late August the farmers pray for cloudy nights and the government sends out priests with "frost-prevention" jars, which are ceremoniously buried on mountain tops. These contain bits of barley, silk, gold, and silver, and their preparation is attended by magical rites. Locusts are not unknown. They are regarded as incarnations of a class of beings dwelling in the fifth lowest of the six worlds. There they are tormented with perpetual hunger and thirst for having been covetous, gluttonous, and uncharitable. Rats may also do considerable damage. Hail—attributed to the warring of the elements of wind, fire, and water—is a major menace and is believed to fall mainly in regions where the inhabitants are quarrelsome or where many illegitimate children are born. The Ngakpas, a group of practitioners especially versed in the proper charms, are employed to prevent hail. General precautionary measures for the safety of the crops include the burning of incense on the house tops in the early morning, particularly in the first half of the month other than the first day, general prayers, and processions around the villages with the carrying of prayer banners, sacred books, and other ritual objects.

The peasant may be an independent small landholder, but he is more likely to be bound to the soil in a feudal tenancy relation to a great landowner, either private or corporate (as one of the large monasteries). He is in the latter case unable to leave without the landlord's permission, which is not often given and must usually be bought. Penalties for unlicensed departure are severe, and, furthermore, the spirits of the village are likely to be wroth should the native leave his soil. Agricultural labor is apparently at an even greater premium than arable land.

Cultivating communities preserve grazing grounds for the stock they must keep for draft and food. Essentially communal, the grazing grounds are subdivided and allotted by the throw of dice. Their use rotates, and the rents charged therefor, which differ for different animals, go into a communal fund. Farm animals are likely to be yaks and other cattle, ponies, mules, donkeys, dogs, and some pigs (the latter usually kept by the Chinese). One or more Newfoundland-size, shaggy, black-haired watchdogs are usual at every house. Ponies are kept for riding and transport, as are mules and donkeys. The latter are cheap, and all men can ride. The yak and its cross-breeds are the most useful of Tibetan animals (Fig. 10). They furnish foods of flesh, butter, and cheese; transport for both men and goods; wool used in the manufacture of ropes, felt and textiles, and blankets; hides for clothing, trunks, bags, and boats; dung, which is Tibet's only significant fuel supply; and even a primary article of Tibetan export, namely, their tails. These may become ritual objects in Hindu temples or merely fly whisks. Noteworthy is the fact that they are especially prized when white.

(To be concluded)

CORK CULTURE IN THE UNITED STATES*

By GILES B. COOKE

CORK is a critical war material and a necessary peacetime commodity. For prosecuting the war, cork is needed for cartridge plugs, bomb parts, insulation, gaskets of numerous kinds, and many other articles essential to a modern army and navy. Non-military uses of cork are numerous and include corkboard insulation, stoppers, liners for bottle caps, life preservers, inner soles for shoes, gaskets of many types, and various other articles.

At the outbreak of the present World War, all private cork inventories within our country were taken over by the United States Government. Use of the limited amount available was controlled by government agencies, and only by sharply restricting non-military uses of cork was the supply made to meet defense needs. Owing to the neutrality of Spain and Portugal, a limited amount of cork was brought to the United States during the first three years of the war. Rigid rationing has enabled wartime imports to meet essential requirements. The liberation of Algeria and the control of the Mediterranean by the United Nations improved the cork situation and eased the four years of tension. However, the cork situation today is very unsettled and the use of cork is still regulated by the War Production Board.

* All illustrations courtesy, Crown Cork & Seal Co.

LARGE CORK OAK GROWING IN GEORGETOWN, GEORGIA

STRIPPING THE LARGEST CORK TREE IN THE UNITED STATES

THIS TREE, GROWING ON THE GROUNDS OF THE STATE HOSPITAL IN NAPA, CALIFORNIA, MEASURES 58 INCHES IN DIAMETER AT BREAST HEIGHT AND IS 75 FEET TALL. IN JULY, 1943, CORK WAS REMOVED TO A HEIGHT OF 17 FEET AND 1,050 POUNDS OF GOOD CORK OBTAINED, LARGEST QUANTITY TAKEN FROM ANY U. S. TREE.

Practically every adult person in the United States has used or observed cork in the form of bottle stoppers or crown cap liners. Only a limited few are familiar with the source and production of this essential product of nature. Cork is the bark of the cork oak tree which grows along the shores of the Western Mediterranean, being indigenous to the soil and climate of this region. Since man first learned to utilize this unusual bark of the cork oak, the world's supply has come from this limited area.

For normal peacetime manufacturing requirements in the United States about 160,000 tons of cork are imported annually. In 1937 the value of unmanufactured cork brought into the United States was seven times the figure for 1899, thirty-eight years earlier. This increasing demand for cork products here, as well as abroad, has had its effect on the cork-producing countries, and special efforts have been made to conserve cork forests and properly market the harvest. Numerous scientific papers relating to cork culture have appeared, particularly in Portugal, during the past three decades. This attention to corkwood has resulted in a large increase in cork production in practically all the cork-producing countries.

Attempts have been made by other countries to grow the cork oak. Experimental plantings of cork trees have been made in Australia, Uruguay, Argentina, Japan, Russia, and the United States. These countries realized the importance and economic value of having cork trees growing at home. Only limited information is available regarding the extent of the plantings or the results obtained outside of the United States. It is entirely possible that after a reasonable time for growth elapses sufficient cork for essential requirements will be produced in some of these countries.

The need for a domestic source of cork was apparent to the founders of our government. At the same time they were fully aware that the soil and climate of the southeastern states were suitable for growing cork trees. In 1784 Thomas Jefferson was sent to France to aid in the negotiation of trade treaties. While there he was elected to honorary membership in the Agricultural Society of South Carolina. Jefferson acknowledged the honor with thanks and at once went to work as a very active member. In February, 1787 he sent a package of cork oak acorns to William Drayton of "Magnolia" at Charleston. These cork acorns were received by Drayton and planted but no trees were obtained from them. The acorns were three months in transit and, based on present day observations, were, without doubt, nonviable when William Drayton received them. For forty years Thomas Jefferson labored to establish the cork oak in the United States. In April 1826, six weeks prior to his death, he wrote to Dr. Emmett, Professor of Natural History, University of Virginia, recommending the planting of cork trees.

Holmes I. Mettee

CHARLES E. McMANUS

ORIGINATOR AND SPONSOR OF CORK PROGRAM IN U. S.

The United States Government became interested in planting cork trees about 1858. Cork oak acorns were obtained from Spain by the Patent Office (the United States Department of Agriculture was not established until 1862) and distributed in the southeastern states and California. Many of the acorns and young trees of this planting were lost. However, a few trees survived and from a United States Department of Agri-

NURSERY AT SUPERIOR, ARIZONA, GROWING 50,000 CORK OAK SEEDLINGS ANNUALLY

culture report written in 1877 by F. B. Hough we read:

> In 1858 and, it is believed, at an earlier period, quantities of acorns from the cork oak were procured from the south of Spain and distributed from the Patent Office to those sections of the country where it was thought they would thrive. A report made at the close of 1875 from Winnsborough, South Carolina, shows that all the acorns planted in 1859 came up and made healthy plants. Three of these are now 24 feet high and over 27 inches in circumference. Two trees, at least, are flourishing at Orangeburg, South Carolina, and there are probably elsewhere in the South examples of successful planting of this tree. The cork oak requires a warm climate, but the southern states and California appear perfectly well adapted to its wants.

Some of the cork oaks that survived this early planting are today magnificent specimens, having large trunks with wide limb spread.

In 1880 more cork acorns were obtained and distributed to many places in the southern states, Arizona, and California. While some trees from this planting are still alive, many of them were lost. From time to time a few cork trees have been grown through private effort. Also, local plantings have been made in several states. A substantial planting at Chico, California, in 1904 has resulted in more than 600 cork oaks—the largest stand of cork trees in the United States. In 1914 some cork acorns were obtained from Portugal and planted in northern Florida. A substantial number of trees were obtained, but a severe storm a few years later destroyed most of them.

Some time ago, Charles E. McManus, President of the Crown Cork and Seal Company, examined a number of these cork trees and at once recognized the good quality of the cork. Realizing the possibilities of a domestic source of cork, he established a Cork Project to promote the growing of cork oak trees in the United States. Under this project, the company assumes the costs for collecting cork acorns, growing seedlings, and distributing the seedlings or acorns. Insofar as possible, all cork acorns produced are collected. After planting, the trees become the property of the planter. Efforts are made to locate all existing cork oaks, and the cork is removed from a few trees in selected areas every year for thorough testing. Specimens of soil are taken from under widely distributed cork trees for laboratory examination and classification.

The Cork Project is wholly a philanthropic enterprise. The interest and enthusiasm with which it has been received are very encouraging. Owners of mature cork oaks are cooperating by offering their trees for

experimental stripping and by donating their acorn crops. The United States Forest Service, Extension Foresters, State Departments of Forestry, Forestry Departments in the Universities, and local Agricultural Agents are cooperating with the Project. With such united effort much has been accomplished in a minimum of time. Already thousands of young cork trees have been planted from California to Florida, and the program calls for not less than a quarter of a million cork trees in 1944 and succeeding years. However, the requests for cork trees are far in excess of the number of acorns and seedlings available.

California has more cork oaks than any other state. About 4,000 trees have been located in California where they are growing in parks, along the highways, about public buildings, and on private estates. Some of these are magnificent specimens. Los Angeles County alone has more than 1,000 cork trees. A cork tree on the ground of Napa State Hospital measures 58 inches in diameter at breast height and is 75 feet tall. Scattered throughout the state there are many other large cork oaks measuring more than 40 inches in diameter.

During the past four years more than 100,000 cork seedlings have been planted in California. The cork acorns are collected during the fall and winter by the local foresters with the aid of boy scouts or members of 4–H Clubs. The acorns are packaged or bagged and shipped promptly to designated state nurseries where seedlings are grown and distributed by State Forest Rangers. The seedlings are grown by planting acorns in tall tar-paper containers that are about three inches across and twelve inches deep. They are free to any person desiring to grow cork trees, and applications are made through the local farm advisor to the Extension Forester at the University of California. In Arizona 50,000 seedlings are grown annually at a nursery located near Superior. This state has about forty mature cork oaks but many of the cork acorns for planting come from California. One old cork tree in Arizona is growing at an elevation of 4,520 feet. It has many times been subjected to temperature extremes of 110 degrees in summer and zero in winter. Scattered through the southern states from Virginia to Louisiana are interesting specimens of the cork tree. Being an evergreen the cork oak is very attractive and the old trees in the South were grown for ornamental pur-

CORK OAKS, CHICO, CALIFORNIA, LARGEST GROVE IN THE U. S. PLANTED IN 1904

BRANCH OF A CORK OAK WITH PARTIALLY DEVELOPED ACORNS

poses. Twenty cork oaks have been found in Georgia and additional ones are still being located. South Carolina has about sixteen, Virginia four, North Carolina five, Alabama five, Louisiana seven, and Florida three. United States Department of Agriculture reports show that cork plantings have been made in Mississippi and Texas. Records have been found of a number of large corks that formerly grew in the south.

It is obvious that cork can be grown where healthy cork trees are now growing or have grown. Tests are being conducted to determine other sections suitable for growing cork. During the spring and fall of 1942 more than 1600 seedlings were distributed throughout the southern states from Virginia to Texas. These experimental plantings were made on various types of soils, in locations having different rainfall, drainage, and sunshine. In 1943 more than 3,100 pounds of cork acorns were distributed in the South. Some of the seedlings from these acorns were distributed last fall and others will be planted this spring. More than 4,000 pounds of cork acorns will be sent to the southern states in 1944.

An exhaustive study of soil, climate, rainfall, and temperature conditions in the United States has been made and the data compared with that of the cork producing sections of Spain and Portugal. From this study a physicogeographical map showing the potential cork producing areas in this country has been prepared to serve as a guide in planting cork trees. However, seedlings have been distributed to persons outside of this theoretical cork area, since it is entirely possible that some of the sections of our country indicated as less desirable for growing cork may produce satisfactory cork.

The quality of the cork taken from trees in selected sections is excellent. In California more than ten tons have been removed during the past four years. In 1942 more than 2,300 pounds were removed from three old cork oaks in Sonoma County. The large tree at Napa was stripped in July, 1943. Cork was removed to a height of seventeen feet and 1,050 pounds of good quality cork ob-

Paris May 6. 1786.

Your favor of Nov. 23. . . . . I expect in the same season from the South of France, some acorns of the Cork oak which I propose for your society, as I am persuaded they will succeed with you.

Wm Drayton esq. Th: Jefferson

Paris Feb. 6. 1787.

I had the honour of addressing you . . . . . The present serves to inform you that I send with it, to the care of your delegates in Congress, some acorns of the Cork oak. I am told they must not be covered above two inches deep.

Wm. Henry Drayton esq. Th: Jefferson

Dear Sir Monticello Apr. 27. 26.

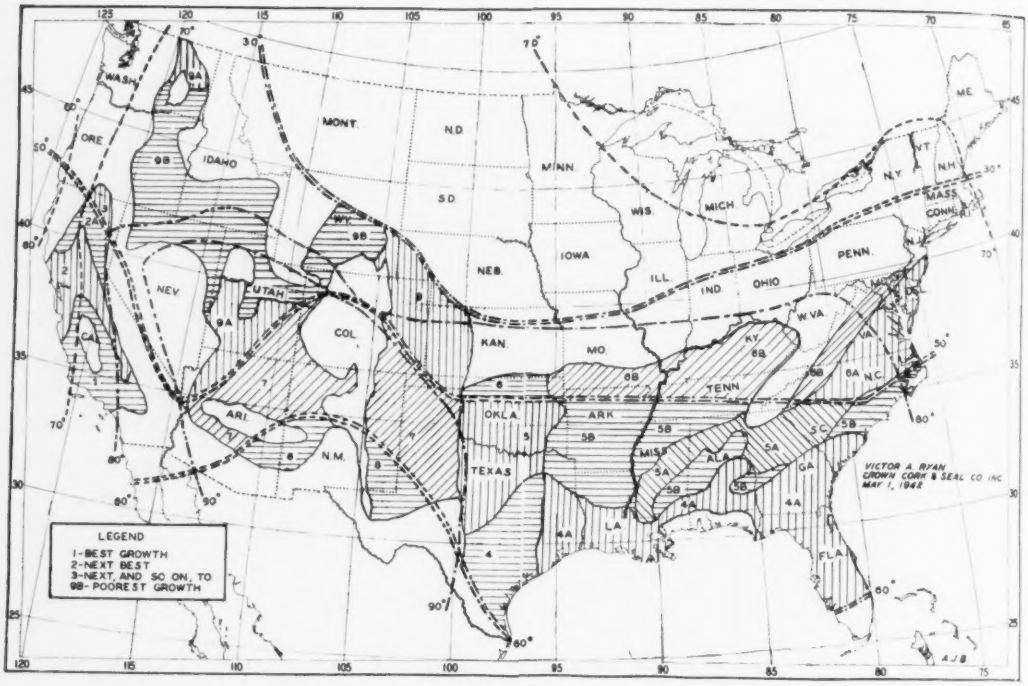
It is time to think of the introduction of the school of Botany . . . . . .

The trees I should propose would be exotics of distinguished usefulness, and accomodated to our climate. such as the Larch. Cedar of Lebanus, Cork-oak . . . . . and Cork-oak, I can obtain from France.

Dr. Emmet
Professor of Nat. Hist at the Univ. of Virginia Th: Jefferson

Library of Congress

LETTERS SHOWING JEFFERSON'S INTEREST IN GROWING CORK TREES IN THE U. S.



POTENTIAL CORK AREAS IN THE UNITED STATES

tained. This is the largest quantity taken from any tree in this country. Cork from southern cork oaks has been found to be of splendid quality. Stripping tests on trees eight, ten, and fifteen years old have been carried out in Georgia. Formation of the second growth of cork will be watched closely and compared with that on the large trees. Trees stripped at Chico in 1940 showed in 1943 one-half inch of new cork. On some trees the three years growth of new cork was equal in thickness to 16 years of first growth on the unstripped portion.

Along with the planting of cork trees many interesting experiments are in progress. Many of the large cork trees in the South do not bear acorns. Efforts are being made to cause these trees to fruit because the acorns are needed for planting. The trees are being given special care and scions from prolific California cork oaks have been grafted to some of them. Tests are being made on the storage of cork acorns. The best time of the year for planting varies in different areas. In those sections where the winters are cold, early spring is preferable to fall for outside planting. Cork acorns must be kept in cold storage until they are planted in order to preserve their viability. Temperatures at 36 to 38 degrees have proved successful.

Propagation by seedlings is being compared with direct acorn planting. The cork oak develops a long tap root and care must be exercised in transplanting bare root stock. The use of tall paper pots which can be placed in the ground eliminates root injury during transplanting. Direct acorn planting is desirable in many places but squirrels, gophers, and rodents destroy a high percentage unless special precautions are taken.

Special work on the rooting of cuttings is being carried out. Experiments in grafting cork to native oaks have produced interesting results. At the present time the number of cork trees planted each year is limited to the cork acorn crop. Development of successful methods for grafting the cork oak to other trees or for rooting cork cuttings would remove this restriction.

Such experiments as these require several years for completion. In the meantime, the maximum number of cork trees possible are being planted every year.

A CRITIQUE OF MEDICAL RESEARCH*

By ALAN GREGG

In using the term medical research, I include all research undertaken with the intent to extend our knowledge of the nature of health and disease in living tissue, and with special reference to human beings. A full list of research activities in, say, the year 1938 in ten of our larger medical schools would show so wide a range of subjects as to leave one bemused at the task of defining medical research. Nor is medical research by any means limited to medical schools: graduate work in the other university faculties may belong to the category of medical research. Meteorological studies upon the nature of cyclonic storms cannot qualify as medical research, though a study of suicides or cardiac failures as related to or influenced by weather conditions could properly be considered an outreaching branch of medical research. The study of the geographical distribution of disease, the nature of inhibition in pigs, and the relation of the *gambiae* mosquito to Crustacea carried from Africa to Brazil by airplanes are examples of the wide range of medical research. The study of tobacco mosaic has more than illumined our knowledge of animal diseases due to viruses. Though I am therefore loath to set the ambit of the term medical research, there can be no gainsaying the fact that by common usage and implication it connotes a potential, if not an actual, application of research to human health and human disease. The gamut of medical research may best be comprehended if we realize that the psychology, the biology, the physics, and the chemistry of today become tomorrow's physiology and pathology and may well become the therapy or the preventive or clinical medicine of the day after tomorrow. And, almost as often, the clinical problems of today may formulate the physiological investigation of tomorrow and pose imperious inquiries to the chemist the day after that.

Possibly the word critique is a somewhat ambitious term for my comments, yet these comments do involve comparisons with accepted standards (the characteristic of a critique), even though they are not marshalled in support of any one thesis, whether critical or explanatory.

Because there are inherent advantages in emphasizing the distinction between strategy and tactics, I had intended to group my discussion around those poles: strategy as the art of deciding when and on what one will engage his strength, and tactics as the skill, economy, promptitude, and grace with which one utilizes his strength to attain the ends chosen by strategy. Just as there can be strategy in conversation—the choice of the subject, for example—or strategy in the matter of vacation—summer, autumn, or winter, boating, fishing, or mountain climbing—there can be, and, more important, there always is, deliberately or inadvertently, a strategical element in medical research. Just as most activities can be viewed in terms of the dexterity, the smoothness, the elegance, the rapidity, the promptness, the economy with which they are graced, so medical research is open to appraisal in terms of its tactics.

I first set out to prepare a paper on the tactics as well as the strategy of medical research, but soon found that scheme too ambitious, too extensive to be covered by anything better than an index of chapter headings: such chapter headings as organization; relation to teaching; recruitment; tenure and retirement policies; the implications of support for research from the state, from industry, from foundations, from private donors; the role of money prizes, of honors and citations; publication problems both in technical journals and the lay press—one can readily see that so many subjects cluster about the tactics of research as to preclude their being included with any remarks on strategy. So I shall not discuss the tactics, the procedures, the practices and methods of medical research, but rather direct attention to the values and the purposes to be served in medical research, what is worth

* An address delivered before the American Philosophical Society on November 19, 1943, and published in full in the *Proceedings* of that Society, volume 87, number 4.

doing, when and on what we may well engage our strength—in sum, the strategy.

Most of us would agree that wisdom is rarer than cleverness, and on reflection it would, I think, be evident that the strategy of research, if not more valuable, is at least more rarely a subject of discussion than the tactics. Strategy is more demanding than tactics since strategy often must reckon with the desirability of doing nothing, or nothing at present; such intentional inactivity is often difficult since inhibition or postponement exhausts nervous energy. Furthermore, strategy, involving the knowledge of what may, and what may not, be worth doing, calls for the exercise of a sense of values, usually a more subjective and always a more mature or slowly developed sense than those accomplishments appropriate for tactical success.

Therefore, perhaps the first strategic question for medical research is this: Compared with other ways in which the time and strength of man could be spent—for example, research in government, in economics, in mathematics, or aesthetic development through poetry, music, painting, or the other arts—does medical research offer a more valuable return? The answer is not quite so obviously affirmative if we ponder on this passage from Hans Zinsser. Writing, of course, of himself, he says:

> He became, however, a profound admirer of Whitehead, who, it seemed to him, combined—in the wide horizon of his mature wisdom—deep erudition of the sciences with sensitiveness to aesthetic values, appearing in this regard to possess some of the qualities, less creative but perhaps more contemporaneously sound, of a Goethe. It was in Whitehead's diagnosis of the sick world that R.S. recognized his own, less learnedly arrived at, to the effect that, with the rapid development of industrialism and urbanization (both consequences of the scientific control of natural forces) there was a neglect of the "aesthetic qualities of the new material environment"; there was a limitation of the "moral outlook" at a time when it was most needed. The "moral pace of progress," says Whitehead, "requires a greater force of direction," but a grooved professionalism (also a consequence of the headlong rush of science) has brought it about that "the leading intellects lack balance" and "the task of coordination is left to those who lack either the force or the character to succeed in some definite career." The corrective, therefore, it seemed to R.S., should lie not in the checking of science, but rather in catching up with it.
>
> Thus, with Whitehead's assistance, R.S. thought he understood the general diagnosis. But that is as far as he got before he died. He stood before the problem as he often stood at the bedside of a dangerously sick patient, helplessly hoping for greater physicians to point a way of cure. He looked to art, literature, and criticism as the instruments through which this might come. For it seemed to him that what had happened was that mankind had been so busy planting the potatoes and corn and turnips of life that it had forgotten to tend the gardens. And now it had no gardens in the enjoyment of which it could find the reasons for which it had planted the potatoes and the turnips. For the arts and the spiritual values which they represent (and this was the pathology of the disease) had come to be regarded as trivial and not worthy of the efforts of serious men, a speculative commodity like stocks or postage stamps for rich collectors or a plaything for amateurs and eccentric incompetents; at best, a civilized amusement or a hobby.[1]

In my mentioning any challenge to medical research, you may be reminded of the advertisement in a Viennese newspaper which ran "Wanted: two hours' argument from an elderly gentleman opposed to matrimony, by a young man resolved to marry." I do not pose the primary question as to the essential worth of medical research just as a bit of target practice. The reason for asking ourselves whether medical research deserves all the time and strength it demands is simple but cogent: if we recount *why* medical research is worth-while, many of the secondary questions of what *kind* of medical research we should do will be brought into far clearer definition and perhaps into correct subordination to the larger issues.

Let us then state why medical research is worth-while.

Now the first and foremost reason for employing our strength on medical research is that to do so maintains and sustains a rational, in place of a superstitious, view of being alive—a rational interpretation of Life in its myriad forms and functions. By medical research we not merely learn important new facts, we learn a method of thinking about what is already known. By means of research we can reformulate the known, as well as master the unknown by a process of modest but relentless attrition. This rational interpretation of Nature—a heritage from the Greeks—could, I think, be shown to be infinitely precious in the chief study of man-

[1] Hans Zinsser. *As I Remember Him:* 422–423. Boston, 1940.

kind, which is man. Human conduct has never been continuously rational, and yet, when by research we finally may master all the mainsprings of behavior, we shall have a rational interpretation of human conduct even when it is irrational—in place of the passionate confusion of today.

The second reason for thinking medical research worth the strength that may be poured into it is intuitive and unanswerable: it is a property of life to defend and protect its being. Now that we can investigate disease and so control it, we shall do so in self-defense. The threat of disaster stirs our primitive emotions. By so much as a disease strikes early, it releases the protective sentiments of parents toward their children. By so much as a disease leaves the patient's character intact while moving slowly and unswervingly to death, medical research upon such disease will never lack the sympathy, the interest, the hope, and the support of those who have the double privilege of thinking and giving. Perhaps it is more than a coincidence that diseases causing changes in character, and diseases terminating in swift and unexpected death, have been the last to receive support for their study. Almost always, changes in the character of a patient affect his friends and family—their sympathies are profoundly disturbed and horror and aversion outstrip pity. In diseases where death is never seen plucking at the sleeve but is swift, unheralded, and masterful, hope, and so reflection, have not time to dispute the issue.

The third reason why medical research should receive the investment of time and strength is that the medical sciences have a right to share with other sciences the glorious freedom of curiosity implicit in the words "Pure Science." If one feels an almost sensuous pleasure in the discovery of order and natural law, he will not have to fall back on the reassurances that "curiosity pays" or such phrases as "the usefulness of useless knowledge." To be informed that Pure Science Pays, always reminds me of the early missionaries to Hawaii of whom it was said, "they went out to do good and they did very well." So precious and exhilarating an elixir of intellectual life as curiosity, I prefer to take straight, without bush or adulterant.

Because medical research tends to place the study of man on rational grounds, because it offers free range to intellectual curiosity, and because its concern with the protection of life is an axiomatic and inescapable extension of the instinct of self-preservation, we may settle the first strategic question by affirming that medical research, when compared with other types of human inquiry, solicitude, and activity, at least deserves all the attention it has thus far received, favorable as this has been of recent years.

With no further hesitation or reluctance as to value of medical research, we may turn now to the more tangible and debatable questions—when and on what research may we wisely engage our strength?

Now the first comment on the actual strategy of medical research is that it is becoming too rare an experience. This experience in selecting research projects, in estimating their possibilities and appraising their performance, has tended to become the function of persons outside the ranks of actual investigators. It is a privilege which of late has fallen to the officers of the Foundations, instead of remaining the responsibility of the investigators or the administrators of our universities. The treasurer's report for 1942 in a well-known western university showed a total of $847,000 in contributions for current purposes, of which less than $47,000 was reported as unearmarked money. With less than five percent of the research funds on which to exercise their powers of discrimination and selection, the faculty no less than the administrative officers may be expected to lose first their liberty, then their responsibility, and finally their ability to exercise judgment as to what research is worth doing. It is my personal conviction that the Foundations have established a fashion of giving earmarked funds, which has been followed by a large number of private donors, and which possesses, among obvious attractions, some serious eventual disadvantages for the recipient institutions. Principal among the disadvantages are the emphasis placed upon showmanship and expert mendicancy, the atrophy through disuse of the critical faculty, the loss of responsibility for local problems and of pride in tackling them inde-

pendently, and finally a restlessness that is second cousin to the restlessness caused by absentee ownership. So forceful a group of accusations would deserve more than the word "disadvantages" if they were all to be found always in full-blown development. They are never complete, but partial and varying in intensity. For it must be remembered that many a gift for research is a direct answer to a request for funds which was born free and untrammeled in the mind of an investigator. Nonetheless, strategical experience, that is, experience in selecting research problems and projects, is on the whole too infrequent in our medical schools, and the impact of war research contracts can naturally do nothing to offset the diminishing exercise of free choice.

The one device explicitly designed to correct the predominance of earmarked-financing of research deserves attention. It is the so-called Fluid Research Fund—a pool or account from which, under exclusively local guidance, sums are withdrawn for the support of selected research projects. I do not believe, however, that deciding how money is to be spent is research strategy. Deciding what is worth doing is strategy; having money at hand encourages the business of securing such experience in strategy. We are foolish not to distinguish money spending from research strategy. And I need hardly add that unless the discrimination and the fearlessness of the Fluid Research Fund Committee are of a singularly high order, the results in work wasted and feelings bruised will not speak for the continuation of Fluid Research Funds. No more generally useful gift than a Fluid Research Fund could be made to a medical school resolved to provide the intelligence and protect the integrity required by a fully responsible committee.

"When and on what shall we engage our strength?" runs the strategist's question. Merely to consider the question "when?" reveals the difference between two kinds of research which, like two arrows held in the hand, overlap for most of their length though they point in opposite directions. We may postpone research until there are some "good leads," some promising hunches, some encouraging suggestions that we are not far removed from a find. Or, lacking any leads or promising indications but in most urgent need of finding something somehow, we may not wait but push research forward in desperation. To the question "When shall we engage our strength in research?" one type of response waits for favorable conditions, the other cries out "Now!—We must!" Needless to say, the one form is common in peace, the other in war. I have often heard that the methods of wartime research should be applied in peace, as well as laments that the criteria of peacetime research are foregone or forgotten in war. Obviously the point of departure, the motivation, and the results of the two types of research are radically different. When war demands a specific problem be tackled, the focusing of every sort of applicable ideas and experience is called for. In peacetimes research is not so hard pressed and tends to weigh more carefully the state of current knowledge and the leads it provides, the quality of the researcher and the assistance provided him in colleagues, consultants, assistants, and equipment. The conditions of war and peace are radically different and so are the motives of research workers, but the contrast ought to be instructive. If war research in medicine can teach peacetime research anything, it probably is this: if A and B are working on problems complementary or otherwise closely related, it is a particularly wise expenditure of research funds to pay the expense of visiting each other. This is constantly done in war and all too rarely done in peacetimes. Also it seems obvious that wartime research will demonstrate the remarkable effectiveness of co-ordinated research programs, as well for medicine as for other subjects. In the rather remarkable speed with which some programs have been executed we forget that freedom from teaching has released energies otherwise exhausted in peacetime. And we forget that wartime research operates on very large financial resources and that patriotic self-sacrifice oils many a bearing that would heat up with the friction of peacetime competitiveness and jealousy.

Before naming some areas of present ignorance (and, I hope, future knowledge) which will probably receive the strategist's attention, I would like to insist that the pri-

mary and almost sacred right of choosing a subject to be studied, of framing a hypothesis to be tested, of planning and performing some crucial experiment, belongs not to the donor or the administrator, but to the investigator himself. If this privilege is not explicitly declared to be that of the investigator, the suspicion will soon sporulate that medical research should be directed from a strategical G. H. Q.—a concept so remote from my convictions and so repugnant to my taste as to call for repudiation at once.

Indeed, I have had experiences that make me wonder whether young scientists in this country feel quite as free to choose their own problems as I would like to have them feel. For a number of years I used to talk with candidates for advanced fellowships of The Rockefeller Foundation. They came from different countries and were the result of different systems of education and maturation. To the question "What do you want to do on your fellowship?" the American usually replied in terms of a problem certainly set and probably selected by his professor. This seemed so much less frequently the case with candidates of other nationalities that I came to expect it as the American answer. Was it a continuation of our national inclination to suffer children gladly, prolong adolescence patiently, and deliberately defer maturity? Or was there nothing national about it? When closer observation showed that fellowship candidates from the Middle West formed a group quite at variance with all the other Americans, the phenomenon became more interesting. The Midwestern candidates usually know what they are interested in themselves: why Midwesterners do not as frequently mirror their professors' interests as the rest of the Americans, I do not know.

If I am right in my impression that American medical research at present is not particularly hospitable to the young investigator who formulates completely fresh hypotheses in fields not familiar to his seniors, then we should find in research literature today a rather large number of instances in which the primary or germinal observation has been made by young investigators not in the United States but in other countries. After ten years abroad and ten years at home, I would be inclined to think that there are countries where more value is attached to independence and originality of thought than in this country. We Americans have been inclined to belittle the brief report of foreign literature that contains an observation and a hypothesis to fit it but lacks complete substantiation or massive proof. Sometimes I think we forget what the last war did to the strength of European laboratories, that they commonly have not been the equal of the German chemical organization. And we forget that it is by just such incomplete but fresh, independent, and pioneer observations that some of our largest, most fashionable, and most heavily laden scientific caravans are led. One should not take offense at an observation in some ways more favorable to others than to holders of American passports. In the generation before mine a number of influential American medical leaders knew and understood European medical science through study periods there. Today, I do not suppose there are four deans of American medical schools who have studied as much as two years anywhere outside of the United States. Lack of travel or foreign residence at an impressionable age makes for parochial horizons, and I think we may as well admit that we now have the elements of a continental parochialism—rendered the greater by a nationalism of an intensity rarely if ever equalled.

Another criticism would be far more worth advancing than the complaint that youngsters in American medicine practice something of the chameleon's art. The extraordinary feature of medical research in America in our times is the frequency with which demonstrated ability in research is rewarded by being extinguished. We praise research, we earnestly seek and prayerfully select young investigators of promise, we use productive scholarship and research ability as the cardinal considerations for promotion and even for the selection of professors. We speak warmly of the research career, and after all that build-up we contemplate with almost bovine placidity the professor who can't do any more research because he is too busy fulfilling the prevalent idea of a professor. The situation is not merely a diverting paradox or an academic peccadillo; it is

a stupid and wasteful abuse, committed, like many elusive futilities, in so noble a cause that its correction would seem disloyal.

It would be consoling to think that only in the earlier stages of institutional development is it necessary to sacrifice research to administration, and that once the preliminary planning has been done, men selected and trained to do research will find tradition and circumstances facilitating their natural tastes and aptitudes. But the evidence about us hardly justifies such an evasive hope.

A more common verbal exoneration of the disgrace of obliging men of unusual research ability to devote long hours to teaching and administrative work consists of saying: "Oh, if he didn't like to do administrative work, he wouldn't do it. Besides, if he was really a research man and successful at it, he would let others do the teaching and administration." The fallacy of that particular bit of gratuitous character analysis is that it does not fit the salary and promotion policy observable in all schools (and some institutes), where the assurance of tenure and the reward of salary are attached to teaching and administrative responsibilities, and not to the pursuit of research.

Persons congenitally disposed to seek for something harder and better than laissez faire will bear with me if I mention by way of remedies or solutions three procedures which in some measure at least keep research men in circumstances favorable to their best productivity.

One is the creation apart from the universities of Research Institutes or Centers for Advanced Study. Like quinine in the South Pacific, this is a pretty good remedy but there's not enough of it to go around. But even if the research institutes became quite numerous, they would still have to connect themselves somehow with universities interested in research, in the effort to be near new blood and adequate recruitment. So at long last, the importance of having research men in the universities would be recognized as important after all.

Another remedy is to create special status for research men—to call them Research Professors, or Distinguished Service Professors, and give them extra salary or freedom from large teaching loads. Though such arrangements may have worked reasonably well in some instances, they run counter to common sense in trying to devise a uniform title for exceptional men in suggesting that other kinds of professors aren't expected to do research, and in implying that many men can constantly justify so magniloquent a title and so privileged a position. Probably, however, the greatest obstacle to the establishment of research professors in distinction to just plain professors is the incomprehension of the public. "Why should a teaching institution have duplicate professors who don't teach?" is the layman's query. I believe that there we touch upon the American tradition of higher education which assumes that universities are not societies of learned men with students in attendance, but large places of instruction whose ultimate unit is not a savant but a "class" almost guaranteed "graduation" at a stipulated time.

Now the presently serious aspect about indifference to what happens to the research man when he becomes a professor is not merely the stupidity or the insincerity or the wastefulness of such procedure, but this: that by so much as institutions and men favor research and learning, they can survive social change without vital losses, but by so much as institutions and men become identified exclusively with indoctrination and teaching, they will be used by political groups. In that way lies discredit and possible disaster. The Collège de France survived the French Revolution without much change: the University of Paris was closed.

The third remedy is to maintain as adjuncts or fellows or monitors (any nondescriptive title would serve: the English employ the title "readers") a number of places equivalent to professorships, available to men of research ability but without any conspicuous title or invidious distinction of status. The chief consideration would be to maintain absolute separation, but free passage between this position and professorial status. If the reader had not a complete identity of status separate from the professor, he'd soon be no freer than a substitute; if he could never become a professor, there would be just another dead-end career in universities already quite costive enough.

The essential preoccupation of wise admin-

istration is to create and to foster the circumstances, the human relationships, in which gifted men will be most productive and prodigal of their gifts. There are those who produce best in peace, there are those who produce best under pressure. The scholar serves his interest more wisely than his comfort. And my thesis is that we need not have all professors, but some arrangements for the scholar who is not a professor—some easy-fitting title that will encourage rather than constrict. Possibly such a change would increase the professor's responsibility for being a competent expositor. In America, hiding themselves in the skirts of Research when someone begins to criticize their incapacities in speaking or writing or otherwise conveying facts and opinions, our professorial brethren condemn the art of exposition, confusing it perhaps with exhibitionism or the like.

In wartime, the selection of research projects is determined in large measure by immediate need, often by pressing emergencies. In peacetime, the selection should be and usually is decided by the imagination of the investigator, operating with the existent knowledge and techniques of his day and age. With these two factors in mind I would venture to predict a few characteristics to be expected in the medical research in the second half of the twentieth century.

We shall be investigating those factors affecting the optimum performance of the organism, not merely the infections, intoxications, and degenerative changes which reduce or destroy its functions. The distinction between sickness and health has tended with the advance of knowledge to become quantitative and gradual rather than a qualitative and abrupt difference. We have already an extensive number of tests to measure degrees of illness. An immense area awaits research upon the measurement or titration of function. Current studies of the performance of heart, lungs, and central nervous system at high altitudes illustrate this coming exploration of conditions affecting optimum functioning of organs, organ systems, and organisms.

Such studies upon external factors affecting performance will eventually and certainly direct attention to intrinsic or inherent differences between performers. So striking will be the results of early studies in individuation that a likely impetus will be given to anything explaining or even partially illuminating the remarkable uniqueness of every human being. From three quarters, besides the measurement of functions, I would expect light—the conditioned reflex studies, long-span studies of nutrition, and long-continued studies of human inheritance. Indeed, for the adequate execution of studies in human genetics we need among scientists something of the continuity as well as the abnegation of the religious order, without, I hope, any of the incalculable genetic losses inflicted on the human race by most of the celibate religious orders. Some new organization of researchers must be evolved to carry on those studies of human phenomena which require many years to complete. We have had a foretaste of such studies in the researches on child growth and development. In this field the tendency has been steadily to extend the period under which the individuals are under study. I have mentioned long-span studies of nutrition since it is evident that not merely temporary individual nutritional status deserves attention—which it is beginning to receive—but the effects of nutrition on animal colonies over periods of time adequate to establish the results of diets on genetically known stock in terms of their reproduction and survival. Probably other psychological approaches should be added to the conditioned reflexes—in order to reveal the slow and cumulative experiences by which an individual becomes unique. Certainly the medical research of the second half of this century will emphasize the function of the nervous system, from the study of the nerve impulse to psychology and psychiatry.

Surely any discussion of values in current medical research could well afford mention of subjects seemingly neglected or temporarily ignored but which might probably or desirably receive attention in the future. One is torn between the prophecy built upon conviction and the prophecy born of hope. Whether a statement belongs in the plain future indicative, the subjunctive, or the optative mood, it is hard to be sure.

In any event I should like to name a few fields for research in which the value for human life would seem to justify a great deal of effort. In the first group are subjects almost sure, under any circumstances, to be pursued in the predictable future with increasing vigor: in the second group I place subjects the strategy of whose future I would less willingly see left to chance.

The airplane and the great expansion of travel in this war and in the future will favor nosogeography—the geography of disease—and its natural corollary, the study of the relation of climate to disease and health. Let me add that there is no reason why meteorological medicine cannot enjoy the benefits of being an experimental science, with advantage to animal husbandry as well as to man. It would be natural in the light of our discoveries in nutrition and in psychology to emphasize the influence of man's surroundings, for it dawns upon an increasing number of investigators that to comprehend what man is, one must be prepared to study what he takes in from his environment and what are his external relations as well as his internal arrangements. This type of consideration will give an ecological flavor to many a research project—and the environment may be dealt with in a wide variety of terms—sociology, epidemiology, political or industrial organization, or psychological stimuli. In the light of the certainly increasing average span of human life the degenerative and the chronic diseases will receive greatly increased attention. Geriatrics may well establish its entirely logical claims to serious attention.

Among my major hopes let me record the wish that biophysics be soon recognized as the brother of biochemistry, even if the time is now too late to consider it the twin. If the last world war was in a sense fought by the chemists, this war is similarly being won by the physicists. Is there any reason for not expecting great things from establishing facilities and careers for biophysicists? One of the natural outgrowths of such a preclinical science might be the now long overdue development of physical therapy in this country. One should not conclude that I think it time for chemistry to cede place to physics. On the contrary, the development of chemotherapy in this country has called for support for the last twenty years. I should think the life insurance companies could try to regard themselves as intelligent businesses rather than timid trustees laboring in the light of stained glass windows. It would be a mark of wisdom for life insurance companies to put up funds for the support of research in chemotherapy comparable to those the food industry is putting up for research in nutrition. Think of what sulfanilamide and penicillin will save the life insurance companies in the next five years!

Of course the closest companion of first-rate chemotherapeutic research is pharmacological research. I would hope for measures leading to a substantial recruitment of first-rate talent in pharmacology and a far wider application of pharmacological methods to resolve problems throughout medicine.

The time is ripening for the application of genetics to the study of human disease and normal human physiology. As a natural concomitant of increasing knowledge of human heredity, I believe we shall see a growth in the so-called "constitutional medicine" and that facts so obtained will illumine not only disease but the innate functional capacities characteristic of different persons.

Possibly medical research will, in the next decade or two, hold up its method of thought to critical review and analysis. I find the level of interpretation of data so painfully low that, for example, I should like to hear no one attribute a condition to any cause without being obliged to specify whether he meant the cause to be understood as the predisposing, the precipitating, or the perpetuating cause. If, as Francis Peabody insisted, a scientist is known by his mental processes, I believe that explicit and detailed research on the mental processes appropriate in medicine would bring great returns to research if only in the discipline it would establish.

THE VANISHING HAWKS

By STANLEY W. BROMLEY

One morning early in September, 1892, Davis Vinton hitched up his horse and carriage to drive over the long, dusty road that led to Oxford and the Oxford Fair. After leaving the lane and rounding the corner on the main road, he noticed something that caused him to pull up his horse and get out of the carriage to investigate. In the pasture beyond the barway and the stone wall, he saw one of his chickens, freshly-killed, lying on the ground in a welter of gore and scattered white feathers.

Going back to the house, he returned with a steel trap which he set close to the carcass after first moving it so that it was not visible from the road, and then continued his drive to the Fair. Returning at dusk that evening, he stopped to see the results of his carefully laid snare. As he approached, a large bird with one foot gripped securely in the trap rose off the ground the length of the chain. It proved to be a large red-tail hawk in adult plumage. To the best of my knowledge, this was the last authentic record of the red-tail hawk in Charlton, Massachusetts.

The red-tail hawk was the old time "Hen Hawk" of the New England farmers. Although the name was applied in response to the occasional captures of poultry by this bird, the red-tail was mainly beneficial, as it fed almost entirely on destructive rodents and insects.

The red-tail was unquestionably the "common hen hawk" recorded by Timothy Dwight, the first President of Yale University, during his travels in the late 1700's and the early 1800's. Thoreau in Concord in the 1840's took time out from his philosophical soliloquies, which have ever since charmed the reading public, to identify scientifically his "hen hawk" of the buoyant wing and superb flight as the red-tail.

The red-tail was definitely a bird of the open country. It would sit for hours on the dead top of some large isolated tree commanding a view of broad pasture or meadow land where the hawk's favorite prey of meadow mice and red squirrels or chipmunks could be easily seen and captured. This hawk shunned thick woods. For nesting, it chose a tall tree in an old open grove of oaks and chestnuts or hickories, usually on a hillside "where a wide range of view" obtained. In the eastern part of New England it usually chose an old pine in an open grove in swamp or barren sandy land.

It was a common sight, according to the early ornithologists, to see the red-tail soaring in wide circles in the upper air, the sun flashing on its white underparts and cow-red fanshaped tail, or to see it hanging on motionless wings high above its nesting grove on a steep hill, its wheezing notes of protest drifting down from above, dimmed to a sibilant whisper by the distance.

During the "teen" years of the present century, I made a series of population studies on the hawks of Charlton. At that time my ornithological Bible was Samuels' *Birds of New England* published in 1872. I was particularly bewildered by the characterization made in that book of the red-tail as "common" throughout New England. It was soon apparent to me that, forty-five years later, the red-tail not only was one of the rarest hawks in the area under observation but had entirely disappeared as a nesting bird.

Ornithologists for years have been calling attention to the dwindling of the numbers of this big hawk in southern New England. William Brewster, in writing of the Boston area in Hornaday's *Our Vanishing Wildlife* in 1913, listed the red-tail among the disappearing birds of that region, stating that he had not seen one in Middlesex County for years. Forbush, in 1927 in his epochal book, *Birds of Massachusetts*, wrote of the red-tail hawk as breeding throughout New England in the 60's and 70's wherever there was tall timber, but that it had ceased to be a common bird in the twentieth century.

In 1916 I met Mr. Calvin O. Rawson who, under the nom de plume of Jennie May Whipple, during the 70's, 80's and 90's had written so interestingly and comprehensively of the Raptores of Norwich, Conn., in the

famous bird magazine of the time, the *Ornithologist and Oologist*. Mr. Rawson had later moved to Woodstock, Conn. He then stated that there was not one red-tail in southern New England where before there had been ten.

In 1885 Rawson had written:

> In my observations in the O. and O. on the Buteos of 1882, it was noted that a line drawn just outside and around this city [Norwich] would pass through the breeding places of 16 pairs of red-shouldered hawks. Now an avian atlas of this part of New London County would also show that an outer circle, girdling Norwich about 6 miles away would cut through the ancestral homes of 10 pairs of red-tails, all breeding on dry wooded uplands or hillsides.

I also met, in 1917, the Reverend C. M. Jones who used to write of the birds of Eastford, Connecticut, in the same *Ornithologist and Oologist;* he also remarked on the disappearance of the red-tail from its old haunts with the conjecture that its nesting sites had been destroyed by the cutting of the woodlands.

So the passing of the red-tail hawk from many parts of southern New England has been noted; its disappearance has become one of the ornithological ponderables along with that of the red-headed woodpecker, the dickcissel, and the purple martin, all of which vacated southern New England during the last fifty years of the nineteenth century. With the red-headed woodpecker, the cutting off of the last few remaining original oak and beech groves deprived the bird of its winter forage, while the cold, wet spring of 1904 finished the purple martin.

The last nesting record for the red-tail hawk in the Charlton area was furnished by Mr. David Stevens in 1918. During the late 80's he worked at the granite quarry located on a steep rocky hill just over the Charlton line in Dudley, Mass. On this hillside a pair of red-tail hawks had a huge nest in a tall chestnut tree. However, these woods were all cut down during the 90's and the hawks disappeared.

Here we have a clue to one of the reasons for the passing of the red-tail in certain areas. When I made my studies in Charlton from 1914 to 1920, all the old oak and chestnut woodlots had been cut down, and in their place grew thick brush and dense young woods. The red-tail hawk, deprived of its nesting requirements, had simply vanished. Even though the red-tail was probably the most persecuted of our hawks by trap and gun, it remained for the destruction of its nesting grounds to cause it to vanish completely.

There was at that time, during the "teens," a goodly complement of nesting hawks in Charlton but they were of species less affected by the changing ecological conditions. During the six years ending in 1920, I noted six species, averaging 29 pairs of nesting hawks in Charlton township—about one pair per thousand acres. In Stamford, Connecticut, I made similar studies on the nesting hawk populations from 1929 to 1939. Here I found five species, averaging 35 nesting pairs—about one pair to every 690 acres. The nesting hawks in both Charlton and Stamford were, of course, not evenly distributed but occurred where their ecological requirements were fulfilled.

A comparison of the Charlton and Stamford populations may well be noted (Table 1). In Stamford as well as in many other sections of rocky southwestern Connecticut, the lack of the red-tail hawk cannot be

TABLE 1

AVERAGE NUMBER OF PAIRS OF NESTING HAWKS IN CHARLTON, MASS., AND STAMFORD, CONN.

Species of nesting hawks	Charlton, Mass. 1914–1920	Stamford, Conn. 1929–1939
Red-shoulder	10	15
Broadwing	6	8
Sharpshin	6	5
Cooper	3	1(?)
Marsh	3	0
Sparrow	1	6
Red-tail	0	0

ascribed to scarcity of oak woodlands for nesting, although it must be admitted that there are no *open* old groves. Rather can it be correlated with the passing of agriculture and the growing up of the old pastures and meadows to brush which impedes the hunting of the red-tail hawk. The red-tail finds its food in the open. When it attempts to capture prey in the brush it gets into trouble. An incident recorded in one of the last numbers of the *Ornithologist and Oologist* de-

scribes an attempt of a red-tail, in pursuit of prey, to swoop into a thicket of brush with the result that most of its wing feathers were ripped off.

The same ecological factors in the Stamford area have militated against the cooper hawk and the marsh hawk, both of which are birds of the open country so far as their hunting habits are concerned. But the cooper hawk was a vanishing species in the "teens" in Charlton also, at a time when there was still plenty of open country.

The history of the cooper hawk—the old-fashioned "chicken hawk" of the farmers—in New England has been of great interest and has been noted by a number of ornithologists. In the early part of the 19th century this hawk was said to have been rare in New England. Nuttall and other early writers barely mentioned it. By 1872, however, Samuels had noted its increase in New England and, in 1881, Rawson stated that it was the most abundant of the Raptores. Then a decline set in and in 1927 Forbush had noted its decrease in Massachusetts. In 1913, Sage in his *The Birds of Connecticut* said that the cooper hawk "is annually becoming rarer over most of the state."

In 1915 and 1916 I questioned a number of farmers in south-central New England and the consensus of opinion was found in such statements as: "chicken hawks are getting scarce," "not nearly as common as they used to be," and "never see them anymore." The cooper hawk was the hawk most likely to catch chickens and it was presumed that these observations applied to that species.

Born on a farm specializing in the raising of poultry within seventeen miles of the Worcester, Massachusetts, market, one of my earliest recollections as a young boy was that of a hawk—which I later knew must have been a cooper—dropping out of the sky into a field near the farmhouse where young chickens were running loose, the quick clutch of talons, and the bearing away of the victim. Transfixed by the rapidity of events, I saw my grandfather rush to the scene and let drive with both barrels of a 12-gauge shotgun at the hawk mounting in circles overhead. I don't think the hawk was hit, but it did drop the chicken, which fell down on the ground almost at my feet.

Very few chickens were ever lost to hawks in the seventeen years that this poultry farm was maintained, and they were taken by cooper and sharpshins. There were farms in that area then where losses of poultry to hawks were claimed, but the figures were probably more fabulous than factual. Those were halcyon days for the cooper hawk. Many were shot at but few were hit. Most likely to be hit were the innocent and beneficial broadwing and red-shoulder hawks, neither of which I have ever known to take poultry. Both subsist largely on mice, insects, frogs, and snakes.

I recall a farmyard apple tree festooned with the bodies of three broadwings, a red-shoulder, and a sharpshin, dangling from the branches by fishlines secured to their legs. This "hangtree" with its feathered mummies dancing in the wind was supposed to be an object lesson to all hawks—a horrible example to keep them at a distance. The coopers paid not the slightest heed to that warning, but came back time and time again, usually getting a chicken at each visit.

What accounted for the decline of the cooper hawk in southern New England? Probably one factor was the decrease in land under agriculture, particularly the decline in poultry raising on the average farm. Another was the increasing precautions of the specialized poultryman who no longer let his chickens run loose where they might be picked up by hawks or other predators, but protected them by poultry wire.

A singular incident occurred on May 3, 1940, in North Stamford, Connecticut, during the height of the northward migration of hawks. A cooper hawk swooping close to the ground at a chicken in an enclosure hit full-tilt against the poultry wire and broke its neck. An examination showed that the hawk's shortsightedness was due to a blind eye which may have been diseased or injured in some avian altercation.

Starlings exhibit a particular rancor toward the cooper hawk and flock around it in flight, attacking it en masse and usually driving for the eyes of their object of torment. It is possible that a lucky blow would extinguish the sight of this member, and this may have happened to the hawk in question. However, such accidents are probably rare

and would not affect the numbers of the cooper hawk as seriously as lack of food or protection of its wild prey by the increasing amount of cover, both factors of mounting importance. The cooper's mainstay of poultry becomes more and more inaccessible while its secondary fare likewise becomes more unobtainable under present conditions.

Thus good hunting is over for the cooper hawk. It is only in areas where poultry have the run of the farmland that the hawk can catch his chicken. The cooper hawk has always specialized in game or poultry in the open. It has difficulty catching many of the native wild birds. I have seen flickers and meadowlarks elude the swoop of this hawk on several occasions. Its hunting is, moreover, made particularly difficult where the countryside is covered with thick brush and thicket growth.

The extirpation of the quail in many parts of southern New England by a combination of the cold winters of late years and the abandonment of planting small grains by the farmers has no doubt deprived the cooper hawk of another favorite item of food.

In southern New England, therefore, scarcity and unavailability of food and the presence of too much covering brush and thicket areas have produced conditions making the existence of the cooper hawk as a nesting bird precarious, if not impossible.

In a way this chicken hawk symbolizes the erstwhile marginal farmer, whose footloose and errant poultry fed the lean and hungry coopers of former years, and who was impelled by natural and economic forces beyond his control to abandon tilling the stern and rockbound soil of New England and to seek his livelihood in some other pursuit.

A MAN WITH A HOE

As I drew a still fresher soil about the rows with my hoe, I disturbed the ashes of unchronicled nations who in primeval years lived under these heavens, and their small implements of war and hunting were brought to the light of this modern day. They lay mingled with other natural stones, some of which bore the marks of having been burned by Indian fires, and some by the sun; and also bits of pottery and glass brought hither by the recent cultivators of the soil. When my hoe tinkled against the stones, that music echoed to the woods and the sky, and was an accompaniment to my labor which yielded an instant and immeasurable crop. It was no longer beans that I hoed, nor I that hoed beans; and I remembered with as much pity as pride, if I remembered at all, my acquaintances who had gone to the city to attend the oratorios. The night-hawk circled overhead in the sunny afternoons—for I sometimes made a day of it—like a mote in the eye, or in Heaven's eye; falling from time to time with a swoop and a sound as if the heavens were rent, torn at last to very rags and tatters, and yet a seamless cope remained: small imps that fill the air, and lay their eggs on the ground on bare sand or rocks on the tops of hills, where few have found them; graceful and slender, like ripples caught up from the pond, as leaves are raised by the wind to float in the heavens; such kindredship is in Nature. The hawk is aerial brother of the wave which he sails over and surveys, those his perfect air-inflated wings answering to the elemental unfledged pinions of the sea. Or sometimes I watched a pair of hen-hawks circling high in the sky, alternately soaring and descending, approaching and leaving one another, as if they were the embodiment of my own thoughts. Or I was attracted by the passage of wild pigeons from this wood to that, with a slight quivering winnowing sound and carrier haste; or from under a rotten stump my hoe turned up a sluggish, portentious, and outlandish spotted salamander,—a trace of Egypt and the Nile, yet our contemporary. When I paused to lean on my hoe, these sounds and sights I heard and saw anywhere in the row, a part of the inexhaustible entertainment which the country offers.

—From *Walden*, by Henry D. Thoreau

TELEOLOGICAL ARGUMENTS

By ARCHIE J. BAHM

ARGUMENTS for the view that the world has a purpose are many and devious and based often upon curious and dubious premises. In the following, some of the more typical arguments have been selected, stated, and "refuted"—refutations consisting of criticisms typically raised against the arguments. Insofar as the case *for* the view is refuted, the case *against* the view is not thereby established. This case must be established on its own account. Arguments for the view that the world has no purpose, and criticisms of these arguments, have not been included here. As to the validity either of the arguments or of the criticisms, the reader will judge for himself.

Design. Familiar to all is the argument that "the world has a pattern and therefore must have a purpose." Different terms are used to express what is meant by "pattern," such as "design," "structure," "order." Usually the argument is stated so as to involve a purposer. For example, beginning with the assumption that the world has a design, the argument deduces that "there can be no design without a designer and that if a designer produced a design he must have done so for a purpose. Thus, if the world has a design, it must have a purpose."

Critics attack the argument in several ways. They say that the assumption that "the world has a design" is unwarranted. For there is also obvious disorder and lack of design which cannot be ignored in claiming that the world as a whole has a purpose, and it is possible that only our part of the world is orderly and the rest of the world which we do not know is chaotic and disorderly, and design may be merely apparent or a product of the processes of perception in human beings who are uniquely purposive and yet persist anthropomorphically in interpreting all other things as purposive.

Secondly, critics contend that the assumption that "there can be no design without a designer" is false. At least some designs are accidental. For example, ink drops folded in paper sometimes appear strikingly symmetrical. If some patterns are produced unpurposively, then it is at least possible that such patterns as the world as a whole may have have been produced unpurposively. Also, perhaps teleologists have been deceived by ambiguities of the term "design." Sometimes "design" means "intention" or "purpose," as when one asks, "What did you design to do?" Here, of course, "design" involves "purpose." But "design" also means pattern apart from purpose, as exemplified by patterns produced accidentally. Thus deduction of "intended pattern" from mere "pattern" is unwarranted.

Thirdly, critics point out that even if the world has a design and a designer, it still would not follow that "if a designer produced a design, he must have done so for a purpose." For he too might have produced the world accidentally, or he might be designing the world as a consequence of some mechanical necessity rather than as a result of purpose. Finally, even though the world was designed for a purpose in the past, there is the possibility that it now no longer has the purpose that it once had, because it may have lost its purpose, or it may have fulfilled its purpose. If so, patterns produced by previous purposiveness may remain without the patterns remaining purposeful.

Such criticisms seem not to down those who would argue from design. When attacked, they reply not so much by refuting these criticisms as by reiterating their argument in a more plausible form. The three following arguments, from analogy, from complexity, and from evolution are really variations of, or extensions of, the argument from design.

Analogy. "Even as a watch requires a watch-maker, a building an architect, an airplane a designer, a vessel a potter, so the world-machine requires a master-watch-maker, a master-architect, a master-designer, a master-potter. The number of obvious cases is so large that surely the argument from this analogy is warranted. Even

though it cannot be deduced that the world has a purpose, still it seems highly probable."

Critics usually grant that there is some evidence for the analogy and admit that, strictly speaking, the conclusion does have some degree of probability. But the degree is not high. For, while illustrations may be multiplied tiresomely, they nevertheless are selected examples and represent limitations of man's anthropomorphic perspective. Believers tend to see what they look for and the evidence presented represents, even though innocently, a "stacking of the cards." One might, if he tried, find even more illustrations wherein no analogous purposiveness is obvious.

Furthermore, even if the examples were selected without bias and the evidence for purposiveness of parts of the world were overwhelming, still it would not follow that the world as a whole is purposive. The argument from purposiveness of parts of the world to purposiveness of the whole world involves what logicians call the "fallacy of composition." The fallacy in the argument, "This is a bunch of large apples, therefore this is a large bunch of apples," and the fallacy in the argument, "This world is made up of purposive beings, therefore this world is purposively made up," is the same.

Complexity. "Even though some patterns might occur accidentally, man is too complex and intricate to have just happened. Man's chemical, physical, biological, physiological, psychological, economic, political, ethical, aesthetic, and religious interrelations all fit together in multitudes of delicate adjustments. Literary and artistic productions, governments and industries, moral codes and religious hierarchies do not just happen. Such amazing intricateness presupposes purposiveness."

Critics respond in four ways. First, complexity is relative. To anything that is relatively complex, something more simple would seem relatively simple. And to anything that is relatively simple, something more complex would seem relatively complex. The world is more complex than the minds which try to comprehend it, so the complexity of the world seems relatively complex to comparatively simple human minds. Relatively simple minds may be easily amazed. Such amazement at complexity is hardly proof of purposiveness in complexity. Secondly, the possibility that the world is one of pure chance, is made up of an infinite number of elements, and has endured or will endure for an infinite time suggests the possibility that the number and complexity of possible combinations is infinite. If, then, infinite complexity may occur from pure chance, complexity hardly presupposes purposiveness. Similarly, if the world is mechanically determined, complexity of result merely presupposes complexity of cause, rather than purposiveness. Critics contend that those who appeal to amazing complexity as proof of purpose merely reveal their ignorance of the complexity of mechanical causation. Finally, if complexity presupposes purpose, surely it presupposes complexity of purpose. It seems questionable whether any purpose or purposer could be complex enough to take into consideration all of the complexities that actually occur. How could such successive series of so many simultaneous complexities be integrated into a single purpose? One might as easily argue that the world is too complex to have been purposed as to argue that complexity presupposes purpose. Furthermore, if the purpose is at least as complex as its purposed product, what purpose could there be in duplicating the complexity?

Evolution. Although the idea of biological evolution was once ardently opposed by those who believed it inconsistent with the idea of world purposiveness, it is now appealed to as one of the strongest evidences of world purposiveness. "Evolution seems directed toward certain ends. Mere complexity may not presuppose purposiveness, but complexity that is going somewhere does. Evidence of direction is plentiful. Each stage of the reproductive cycle seems to serve the next stage. Each species that developed seems to have served as a basis for the development of later species. The history of biological development toward, and to, purposive man surely must have been for a purpose." Some biologists even appeal to world purposiveness for proof of the previous existence of what some call "missing links." These had to be in order to fulfill the purpose obvious in biological evolution. "Furthermore," some say, "this is a world in which the fit

survive, and since evolution has been rather consistently toward those beings which are more purposive, surely the superior success in survival of the more purposive beings argues for world purposiveness."

Critics accustomed to defending biological evolution in non-teleological terms may be somewhat taken aback by this appeal of teleologists to evolution. However, upon recovery, they contend that biological evolution has been, and for the most part still is, explained without appealing to world purpose. Thus the idea of purpose is not necessary to evolution. That evolution has direction may be admitted, but that direction always implies purpose may be refuted by pointing out that anything that goes anywhere goes in some direction. The wind blows first in one direction and then in another; but this is no evidence of change in purpose or of purposiveness of any sort. Furthermore, if evolution of species serves a purpose, why have some species developed only to become extinct? Some have developed not merely to lay the foundation for higher species in the line of development to man, but for other lines of development which eventually cease. Do some purposes end? Is it a part of the world purpose that some purposes end? Is such purpose as the world as a whole is supposed to have also endable?

Critics point out further that multitudes of simple species continue to exist, to survive, as well as complex and more purposive species. Thus, apparently, development in purposiveness is not essential to survival. Likewise, even if it be granted that more purposive beings survive better than less purposive beings, still it would not follow that such superior success in survival is for a purpose. Survival *of* purpose does not imply survival *for* a purpose. Finally, the argument illustrates human conceitedness rather than objective fact. The purpose of evolution, as thus interpreted, is to develop man, and man is the end, the completion, the perfection of the process. We accept the teleological interpretation of evolution because it glorifies man as a superior product which required so many difficult aeons of preparation. Even those who add that the purpose of the evolution of man is to serve God do so in the interest of human conceit by saying, or implying, that man is the chief object of God's attention, and the trouble God went to in planning such a complicated evolution demonstrates the greatness of God's consideration for man. But, if man could discount his own conceit, he would see that the argument for world purposiveness from evolution would have little basis.

Value. "Even though the previous arguments from design, analogy, complexity, and evolution fail to prove that the world has a purpose, one other additional argument does. Value or goodness exists. Many types of value or goodness exist. For example, the value of life, of hope, of love, of companionship, of beauty, of faith, of honor, of loyalty —these could not just have happened or have been mechanically caused. Literature, music, art, drama, painting, pageantry, and poetry, are more than machine-made or circumstantial products. The ecstacy of love, the sublimity of symphonic music, the peace of worship, the exaltation of success, the inspiration of faith in the future—all of these are values which could not just have happened. Life is too worth-while just to have occurred."

Critics may hedge and hesitate to explain value in non-purposive terms, but usually they hold that even though it is not necessary, yet it is possible to do so. Value consists in pleasant feeling and pleasant feeling is produced in bodies by proper stimulation or, according to at least one psychologist, when synaptic resistance to nervous impulses is decreasing. Such reduction of resistance is explainable completely by chemical and physical interpretation. Value exists in the world because those chemical combinations organized into living beings that produced pleasure survived better than non-pleasure-producing living beings. Synaptic and glandular conditions may cause objects to appear magnificent, grandiloquent, ecstatic, but such illusions merely happen to have been useful for survival rather than to be true ideas about the real world. Values exist, but exist as illusions, albeit happy and pleasurable illusions. Illusions of values may beget illusions of purposiveness, but unless these illusions also are enjoyable there is no point in being deceived by them.

Critics call attention also to the existence

of evil. Values might serve a purpose, but what good is evil? The horror, fear, hatred, anguish, pain, ugliness, nausea, and suffering of life and death are a part of the total picture. There is too much evil in the world for anyone to have planned it that way. The existence of evil is at least as much proof that the world has no purpose as is the existence of good proof that the world has a purpose. If teleologists assert that evil is mixed with the good to make it all better, critics reply that neither the observable suffering nor the common promise of eternal punishment warrant such optimism. If one has to choose between believing that the world has no purpose and believing that the world has a predominantly evil purpose, surely the former would be more desirable.

Progress. "Progress is possible. And progress means development toward something better or more good, toward some goal or end, toward some purpose. If there were no purpose, there could be no progress. But there is progress, therefore there must be purpose."

Critics may admit that progress is possible. But so is regress. Life can get better, and life can get worse. "The best laid schemes of mice and men gang aft agley and leave us nought but grief and pain for promised joy." Who can tell whether our present optimism about a more glorious future is justified? In the end all values may be destroyed. In the end there may be an end to both good and evil. Those who continue to be in torment and anguish say, "Let it come quickly." "Ashes to ashes and dust to dust," and between the two a period of pleasure and pain, which while we have it we should enjoy and hope happily, but when it is ended ends all for us. Purpose there may be, but progress and regress do not prove it.

Cause. "The world was created. If the world had not been created for a purpose, it would not have been created. For to be created or to be caused means to be caused for some reason. If there were no reason for a thing coming into being, it could not come into being. 'Reason for being' is just another name for 'cause.' But 'reason for being' also means 'purpose.' Therefore, to be caused means to be purposed."

Objection may be raised that the assumption that the world was created is highly dubious. For, it is possible that the world always existed, that it had no beginning, that it has been eternally. Or, if it did not exist eternally, then whatever caused it to exist either existed eternally or was caused by something which either existed or was caused by something which existed eternally, and so on. Thus, either the premise, "the world was created," is false, and thus the conclusion does not follow, or the difficulties which one seeks to avoid by postulating creation are simply pushed back to that which did the creating. If the latter be granted, that is, that the world was created, then was that which created the world itself created? If not, then it had no creator and thus no reason for being. Thus there would be an uncaused and unpurposed creator of the world. But if so, the creator of the world must, by the same argument, have been created for a purpose; and the creator of this creator either must have been created for a purpose or have existed eternally unpurposed. Thus purpose must have arisen somehow without being caused or purposed by some ultimate purpose. And even if there were an endless series of creative purposes, one might still ask, "Was the series as a whole purposed?"

Definition of "cause" as meaning the same as "reason for being" begs a question which critics will not admit. Causes are "necessary and sufficient conditions," not "reasons." "Reason for being" is a loose popular expression developed in a background which was saturated with human purposiveness. Neither looseness and ambiguousness of popular usage nor question-begging presupposition of purposiveness can be admitted as proof of world purposiveness. "To be caused" does not mean "to be purposed."

Authority. Except for appeal to design, probably the most common argument is appeal to authority. Especially those who have tried to argue, and seem to themselves to fail, appeal to authority, which sometimes seems to be above argument. Authorities of many kinds are appealed to—eminent men, the Bible, the Church, Jesus, God. This type of argument may be illustrated by the appeal to the authority of God. "God, through

revelation, has said that the world has a purpose, and what God says is so, is so."

Critics are expected to cringe before this appeal to the authority of God himself, yet in fact they seldom do. They rebut as follows: Is there a God? One first has to prove that God exists before he can claim that God is an authority. One of the commonest arguments for the existence of God is the argument from world purposiveness: "The world has a purpose, therefore the world must have a purposer, namely, God." However, such an argument presupposes that the world has a purpose, whereas the present argument for world purposiveness presupposes the existence of God. Using both of these arguments would be to commit the fallacy of "reasoning in a circle." Thus, unless one can find some other proofs of God's existence or can get his critic to grant it, he will be unable to prove his case. But even granting that God exists, it does not follow that the world has a purpose, because God might have created the world accidentally, or have created the world as a result of mechanical necessity, or have created the world in the past for a purpose which he has now forgotten. Furthermore, still granting that God exists, does it follow that God is an authority? God might exist without being a person, or without being actively interested in the world (as Deists claim), or without being interested in acting authoritatively. However, granting both God's existence and authoritativeness, did God ever say that the world has a purpose? All alleged reports of God's speaking to persons in such a way that one might infer that the world has a purpose are dubious. Someone has questioned every one of them. Furthermore, all those who appeal, not to the writings of historical revelators, but to their own experience in communion with God and of his revelation directly to them that the world does have a purpose have been accused of self-hypnosis and self-deception. Also, evidence may be presented for God's non-authoritativeness. For example, there are contradictions among contentions of different revelators and most revelators contradict themselves sooner or later. Such contradictions prove that God was not involved, because God is always consistent.

Self-contradiction by mechanists. "Those who claim that nothing has a purpose do so for a purpose, and thereby contradict themselves. The very laws of mechanics used as a basis for explaining the behavior of things non-purposively were formulated by human minds for a purpose. Mechanists would be the first to discard those mechanical laws which were not suited to their purposes."

Mechanists reply that the claimed contradiction is only an apparent one, not a real one. For mechanists explain purpose in non-purposive, or mechanical, terms. Purpose is a notion in a causally (non-purposively) determined mind. Even if the mechanist seems to those who interpret things purposively to be acting purposively, he claims that such purposes are mechanically caused. Thus he involves no contradiction.

Proof by mechanists. "Since every normal person seems to himself at times to act for a purpose, everyone must admit that there are at least human purposes in the world. If, as mechanists claim, the world is uniform, then if there is purpose in part of it, why not also in all of it? Furthermore, since, for the mechanists, nothing can occur spontaneously but everything must have a cause that is capable of causing it, purposes which do exist must have been caused, and in order for them to have been caused there must have existed in the world other prior purposes capable of causing them. These prior purposes must have been caused by still earlier purposes, either backward infinitely or by some first or ultimate purpose. Thus mechanism really presupposes world purposiveness."

Mechanists may grant that personal purposes constitute a part of the world, but maintain that it does not follow that the whole world is made up of personal purposes nor that the world as a whole has a purpose. "Uniformity of nature" does not mean that everything is alike, but only that when a given set of causal conditions recurs there will result an exactly similar set of effects. Arguments from parts to whole are unwarranted, as can be seen from the example of a worm in a partly rotten apple. If he is in the rotten part, it may seem all rotten. If he is in the good part, it may seem all good. If he is on a border between the two, it may seem either a good apple with a rotten part

or a rotten apple with a good part. One might just as easily argue for non-purposiveness of the whole world on similar grounds, for everyone will admit also that some experiences seem lacking in purpose.

Unprovability of mechanism. "Since human knowledge is limited and since there is much about the universe that we can never know, mechanists can never prove conclusively that the world has no purpose. For even if it were provable that everything in the known universe is non-purposive, it still would not follow that the rest of the universe which we do not know is non-purposive. So long as complete mechanism is unprovable, it is reasonable to suppose that teleology is true."

Mechanists reply with almost exactly the same argument. "Since human knowledge is limited and there is a part of the world which we shall never know, even if it could be demonstrated that everything in the part of the world which we do know is purposive, it still would not follow either that the rest of the world is purposive or that the world as a whole has a purpose."

Universal agreement. "People of all times and places have believed that the world is purposive. Except for a few oddities, everyone believes that the world has a purpose. Can such a great majority be in error?"

Normal rejoinder is that popular agreement is no safe proof of truth of any belief. For thousands of years people agreed falsely that the earth is flat. Likewise, all people naturally believe that color exists in things independently of persons who see it; yet scientists tell us that color as experienced is not really out there, even though naturally we must continue to act as if it were. Such illusion is convenient, useful, natural, and universal, but not for those reasons true. Popular consensus is indicative not so much of cosmic teleology as of anthropomorphic teleology. People believe that the world is purposive, not because the world as a whole has a purpose, but because people are purposive and tend to interpret other things as if they were like people. This accounts for universal agreement about world purposiveness at least as adequately as does the theory that the world as a whole has a purpose. Furthermore, who knows what the popular consensus is? No poll of opinion on this question has ever been taken. No one can say with certainty that everyone does believe that the world has a purpose, certainly not with regard to those of the past who can no longer be polled, nor those of the future not yet pollable.

Pragmatism. Many pragmatists define truth thus: "Those beliefs which work successfully, which are useful in adjusting ourselves to our environment or in solving our problems, are true. And those beliefs which work most successfully are most true." Teleologists who accept this pragmatic definition of truth say, "The belief that the world has a purpose works successfully and therefore is true. Furthermore, people who have faith in world purposiveness get along better and are happier than those who do not. Thus, it works more successfully and thus is more true."

"But," say mechanists, "such success of teleologists is due to the fact that they haven't yet tried to use their belief in areas where it won't work so successfully. Everyone has some ideas which work well for a while or in certain areas, but which have to be given up when used in wider areas or over a longer period of time. Teleologists are simply less-experienced than the mechanists." Using exactly the same definition of truth, some mechanists seek to "turn the tables" by saying that the belief in mechanism works better than the belief in teleology. Appeal is made to the comparative adequacies of the teleological and mechanistic hypotheses in promoting scientific progress. Mechanists claim that most science presupposes mechanism and the progress of science stands as testimony of the superior success of the mechanistic hypothesis. The history of scientific progress is a succession of stories in which belief in mysterious purposes was given up for belief in the reign of natural law. Relative backwardness of the social and political sciences is accounted for because they deal with areas in which people are least willing to give up their illusions about cosmic teleology and accept the more useful mechanistic hypothesis. If the pragmatic test proves anything, they claim, it proves that mechanism is more true.

FRANCISCO HERNÁNDEZ: NATURALIST, 1515–1578

By VICTOR W. VON HAGEN

WITHIN fifty years after the discovery of the New World, the conquest of the Americas was complete. Native resistance had been annihilated. The civilizations of the Aztecs, the Chibchas, and the Incas were reduced sufficiently so that organization could take place. In order to make the new territory easier to administer, the Spanish Crown decreed that the peoples of these vast lands with all their varied customs should be studied and that the native plants and animals should be thoroughly investigated. Henceforth every ship that left Spain carried its historiographers, notaries, lawyers, and eventually natural philosophers, among whom was Francisco Hernández.

Hernández, it was true, had been preceded by others, notably Gonzalo Fernández de Oviedo. As warden of Castillo de Oro, now the territory of Northern Panama, Oviedo had gathered together a wealth of information. But he told too much. The Council of the Indies, who guided the destinies of the New World, was adamant on this point. Because of this, only a fraction of Oviedo's travels and inquiries became known, and his reports whetted, without satisfying, the appetites of knowledge-starved Europeans. Still, Oviedo's work, despite its emasculation, served its purpose, for it aroused the interest of Francisco Hernández, who was to become our first American naturalist.

A native of Toledo, a graduate of medicine from the University of Salamanca, and then, by the grace of his curing talents, Physician-in-Ordinary to Philip II, Hernández became obsessed with the desire to conduct an expedition to *Nueva España,* and there, after exploration, to prepare a complete natural history of the country, including a catalogue of its plants and animals, a history of its ancient culture, and a detailed map of the whole province. Hernández did not allow his desire to remain dormant; he daily besieged his royal patient, Philip, with projects, plans, and charts. At last the King of Spain was convinced. Hernández would lead such an expedition, and it would be financed by his royal purse. Thus in the spring of 1570 the first government-sponsored scientific expedition set out from the Kingdom of Spain.

For five years Hernández and his expedition moved through the length and breadth of Mexico. From the lush lowlands of Vera Cruz and Tabasco to the verdure-splashed hills of Puebla, Morelos, and Guerrero, they picked their way. They traversed superbly cultivated valleys and tramped in primeval jungles. Hernández noted the fine, shapely natives, "who, were they dressed and kept from the sun and air, would be almost as white as in Spain." Yet, most of all, this medico-naturalist was impressed and enchanted by the great varieties of plants and the never-ending parade of birds, from the diminutive hummingbird to the ridiculous-beaked toucan.

Hernández' Mexico was an ancient land which, despite its rape by Cortés and his myrmidons, still kept to its age-old folkways. The Indians were docile, without being, as yet, subservient. They remembered their past and their traditions, and served Hernández well. He was generously supplied with native interpreters and artists; and also with collectors and naturalists, for Montezuma had kept a large aviary.

Hernández traveled everywhere. All the important animals of New Spain were described by him and figured by his artists: the *jabali* or wild pig, the jaguar, the armadillo, chameleons, the hairless Chihuahua, the California horned toad, and even a North American bison. But his most important work was done on the botany of Mexico.

Hernández divided the plant kingdom of the Aztec into two great natural orders, the woody (*quauh*) and the herbaceous (*xiuh*), and subdivided these plants and trees into four great artificial classes according to their uses: the edible, the medicinal, the ornamental, and the economic. Hernández collected medicinal plants assiduously and gave them the greatest attention. He was careful to note from his Aztec interpreters whether a plant was used as a pectoral, stomachic,

diuretic, emollient, or soporific—and where knowledge was lacking, Hernández made himself the guinea-pig. In Michoacan, he purposely swallowed some latex of the plant known as *Chupri* (identified later as a species of the genus Euphorbia, the deadly spurge). For months he lingered miserably between life and death. Then the work went on.

The real value of his subsequent thesaurus resulted from Hernández' recognition of the value of his Indian collaborators. All his information came from these skilled informants, who knew the native plants and their characters, synonymy, and classification—all of which Hernández put into his notes. As he confesses in his thesaurus, they made his great work possible. Native artists illustrated each plant that Hernández collected, and these drawings, with the descriptions of the collected plants, became the basis for his thesaurus. The first eight books or chapters of the volume that was finally published were devoted to botany. His thesaurus is to be regarded as a mammoth ethnobotanical herbal on Dioscoridian lines.

In five years he had filled sixteen folio volumes. In 1576, in the sixth year of his expedition, he retired permanently to Mexico City to undertake the final compilation of his work, preparatory, so he thought, to its publication. But there were several unavoidable difficulties. He encountered the hostility of other Spanish physicians in the provinces and, what was worse, Philip of Spain, who had sent him hither, had failed to give him the needed and promised financial support. Resourcefully, Dr. Hernández went into private medical practice in Mexico to repair his financial bastions. He spent some months at the Indians' *Hospitial Real* where, with the renowned Alonso Lopéz de Hinojoso, he made a special study of a local disease, *cocolixtli,* inspecting many corpses to discover the origin of the disease and a remedy for it. There his patients had the privilege of receiving treatments from the hand of a man who had once prescribed for the august person of a king. By these means, Hernández earned enough to carry on his work.

Up to this time Philip II had done little for the expedition; he had had other worries. Drake and Hawkins were loose on the Spanish Main, in Peru the Incas were in revolt, and a costly campaign by his Armada was planned against the island-kingdom of Queen Elizabeth. However, so impressed was Philip by reports of this stupendous and heroic work of Francisco Hernández that he squeezed 60,000 ducats out of the Spanish treasury for its completion. That sum, unfortunately, was hardly enough. Interpreters, native collectors, artists, wood-block craftsmen, and reams of fine imported linen paper for these sixteen folio volumes ran high.

With the aid of his son, who had accompanied him, he completed, in September, 1577, the sixteen folio volumes which were to form his great work. The thesaurus, which had first been written in Latin, had been put into Spanish, and from the Spanish into the dominant Indian tongue—Nahuatl.

Immediately after the work was done, he left for Spain. Aboard ship he busied himself in compiling a budget of costs for the proposed publication. He even arranged guides for the illustrations, which he had planned to have executed in color. Only a few colored notes of these are extant; but from them one can grasp the excellence and the completeness of this first great work on American natural history.

Arriving in Madrid, he was treated to his first disillusionment! The great work with all its woodcuts, its ethnobotany, its map of New Spain, its wealth of medicinal information was not printed, but instead the folio volumes were exquisitely bound in tooled leather and then were buried in the stacks of the library of the Escorial. This perfidy was a horrible, bitter blow to Hernández. He had no reason to appreciate the "honor" given his manuscripts by interring them in a hallowed place in the Escorial even though, as one contemporary remarks, the manuscripts were "superbly bound in blue morocco, tooled in gold and with locks, clasps and corners—all of high wrought silver." Hernández never recovered from what he regarded as an act of extreme analphabetism. He was now past sixty. His health, already seriously undermined by the privations occasioned by his explorations, was failing, and his earthly dreams were shattered. He had set out to do that which his predecessor, Oviedo, had failed to do—to

give a scientist's view of the New World. He had done his work, but the publication of it was suppressed. Hernández had no heart to go on. Worn out by the penalties involved in his researches, he died a year after his return from Mexico.

Then, some years after his death, as if the gods had planned a sardonic jest, the attention of Philip II was again called to the work of Hernández. Having decided to print it, the King called in Nardo Antonio Recchо and set him to editing the work. Under his commission Recchо was to "extract" the most useful and important parts of the manuscript. Recchо interpreted his instructions as referring chiefly to those parts that dealt with medical information. Thus was lost the completeness of the Hernández text. Yet, had not Recchо undertaken the work and carried back to Naples much of the material for the publication, we should have been infinitely the poorer, since the original sixteen folios of Hernández (along with many another classical report on America) were destroyed in the conflagration that consumed the Escorial in 1671.

After having abridged Hernández' work and prepared it for the printer, Recchо died. The work was willed to Recchо's nephew who brought it to the attention of a great patron of letters, Prince Frederico Cesi, Duke of Agua Sparta, a patron of science and founder-president of the Lyceum-Museum of Natural History. The Prince acquired it at no little expense to himself. Being a man of keen perception and enthusiasm, he commissioned artists to obtain from the archives additional illustrations from the Hernández manuscript. The Prince himself assumed the task of executive editor.

It was not until 1612 that parts of the thesaurus were distributed among specialists for new editing, arranging, and annotating. Prince Frederico wrote a remarkable epilogue for the proposed edition—an essay entitled "*Theatri Naturalis Phytosophicae Tabulae.*" This vague, rambling exposition takes up a large part of the printed work. By 1628 the manuscript was ready for the press. Doubtless Prince Frederico intended to defray the costs of publication, but again death intervened. The Prince left to the Lyceum, as a sacred legacy, the printing of the Hernández' work, but, unfortunately, he left no money to accomplish it. Ultimately one of the members, Francesco Stelluti, sought out the Spanish Ambassador to Rome, don Alfonso Turiano, and from him obtained the money to publish the manscript.

Thus, in the year 1651, what was left of the great thesaurus of Francisco Hernández, the first American naturalist, was finally printed in Rome in one monstrous volume of nine hundred and fifty pages.

PRECIPITATION REGIONS IN THE UNITED STATES

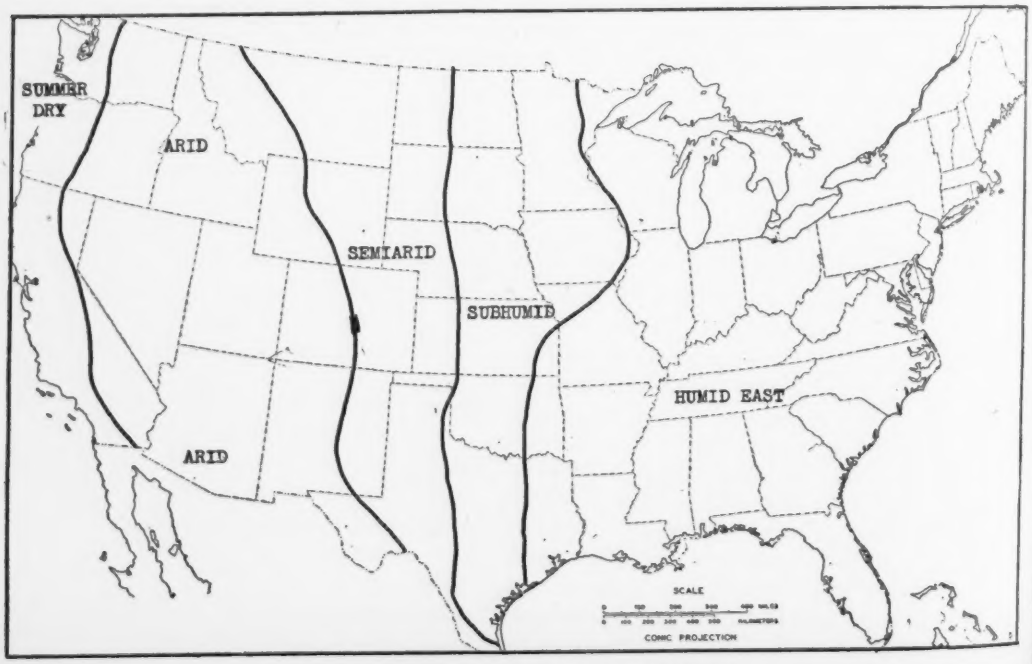
By STEPHEN S. VISHER

GREAT differences within the United States in precipitation, both average annual and seasonal, have encouraged the recognition of precipitation regions. The commonly recognized regions are the humid, subhumid, semiarid, and arid. Areas with an average annual precipitation in excess of 30 inches are called humid, those which normally receive less than about 10 inches are called arid, areas with averages of 10 to 20 inches are frequently classed as semiarid, while those receiving from 20 to 30 inches are sometimes called subhumid.

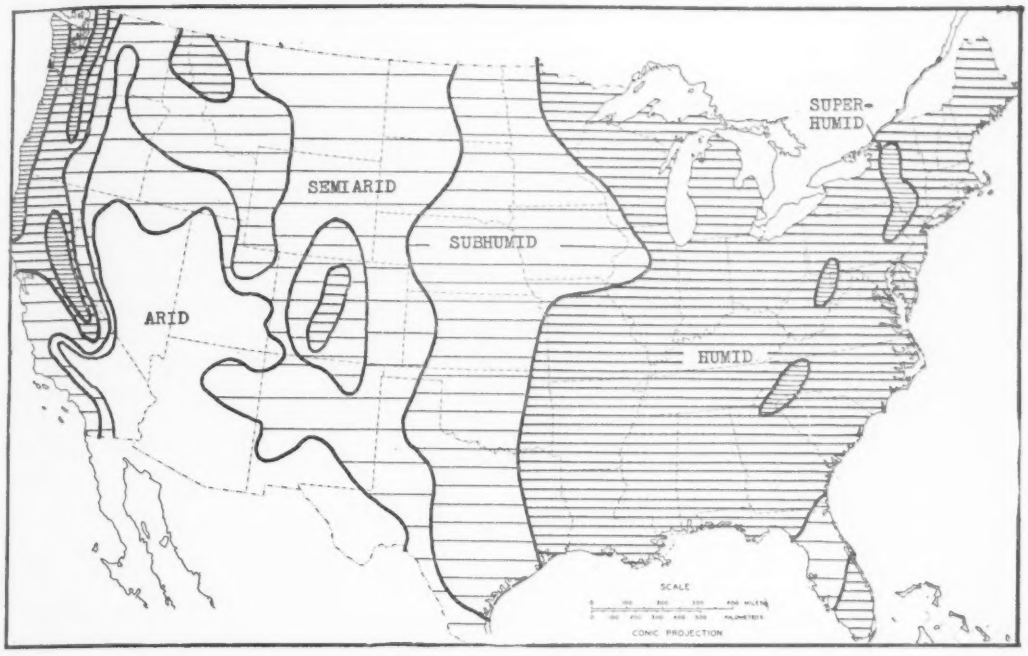
The first two of the accompanying maps show the regions recently recognized by officials of the United States Department of Agriculture. Map 1 is assembled from the locational maps for the chapters in which each of these regions is discussed in the 1941 Yearbook of the Department of Agriculture, *Climate and Man*. Map 2 is a simplified shaded copy of the average annual precipitation-effectiveness map of the "Atlas of Climatic Types 1900–1939," prepared under the direction of C. Warren Thornthwaite.

Maps 1 and 2 reveal interesting differences. In Map 2 parts of Florida and Illinois are classed as subhumid rather than humid, but much less of the West is classed as arid than in Map 1. Moreover, Map 1 does not subdivide the Pacific Coast region as does Map 2. Finally, Map 2 recognizes that parts of the humid region are superhumid.

Factors responsible for differences in precipitation in the major regions shown by these maps are: (1) the position of the United States with respect to the great wind belts; (2) its topography, especially the western mountains and the Mississippi Basin; (3) the presence of many cyclonic disturbances. Significant also is (4) the fact that the United States is part of a large continent which heats up notably in summer but becomes relatively cold in winter. The prevailing westerly winds carry much moisture from the Pacific Ocean onto the western



MAP 1. FIVE PRECIPITATION REGIONS



MAP 2. NORMAL ANNUAL PRECIPITATION-EFFECTIVENESS

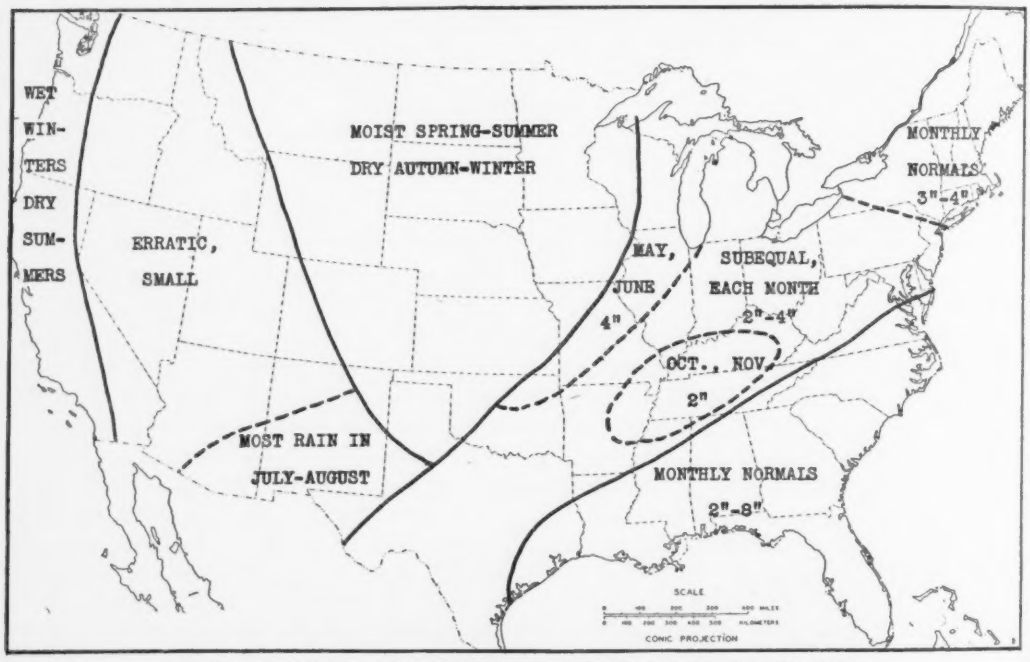
coast, but because of the lofty western mountains, little or none of it reaches the central part of the country. The section east of the Rockies obtains most of its moisture from the Gulf of Mexico, drawn northward by winds blowing into cyclonic disturbances. The center of a disturbance moves rather rapidly eastward across the country. Because the wind moves in counterclockwise direction, the moisture that it carries moves into the country on the eastern arc of its center of rotation. Since precipitation of moisture from these winds declines with distance from the Gulf, it follows that average precipitation increases eastward from the Rockies.

The cyclonic disturbances which affect the United States are of two chief sorts: the so-called mid-latitude Lows and Highs, and the tropical cyclones. The Lows cross the country from west to east, more of them traveling across the northern half than across the southern half. Tropical cyclones enter from the south, or pass northward near the eastern coast, many of them bringing large amounts of rain. Some move slowly in parts of their course; a few of them have such violent winds as to be called hurricanes. Nearly all that enter the country soon lose most of their moisture, thus helping to explain the northward decline in average precipitation in the central and eastern part of the country. A more important cause of this northward decline is temperature drop from sea to land, as in winter, condensing wind-borne moisture before it is carried far over the land.

As to seasonal distribution, five precipitation regions are here recognized (Map 3): (1) a large region extending from Maine to Texas, which normally receives approximately equal average amounts of precipitation in all months (2 to 4 inches); (2) a southeastern region, where the monthly totals range from 2 to 8 inches—thus some months are much wetter than others, but none is normally dry; (3) the Pacific Coast region, where the summers are almost rainless and the winters are wet; (4) a large central region, especially the northern and central Great Plains and Prairie region, where the winters are relatively dry and the spring and summers normally are moderately rainy; and (5) a large western region, often called the arid region, where the precipitation is generally small and is always highly erratic, sometimes occurring chiefly during the cooler months, sometimes during the warmer ones, and sometimes in neither.

The approximate boundaries of these five

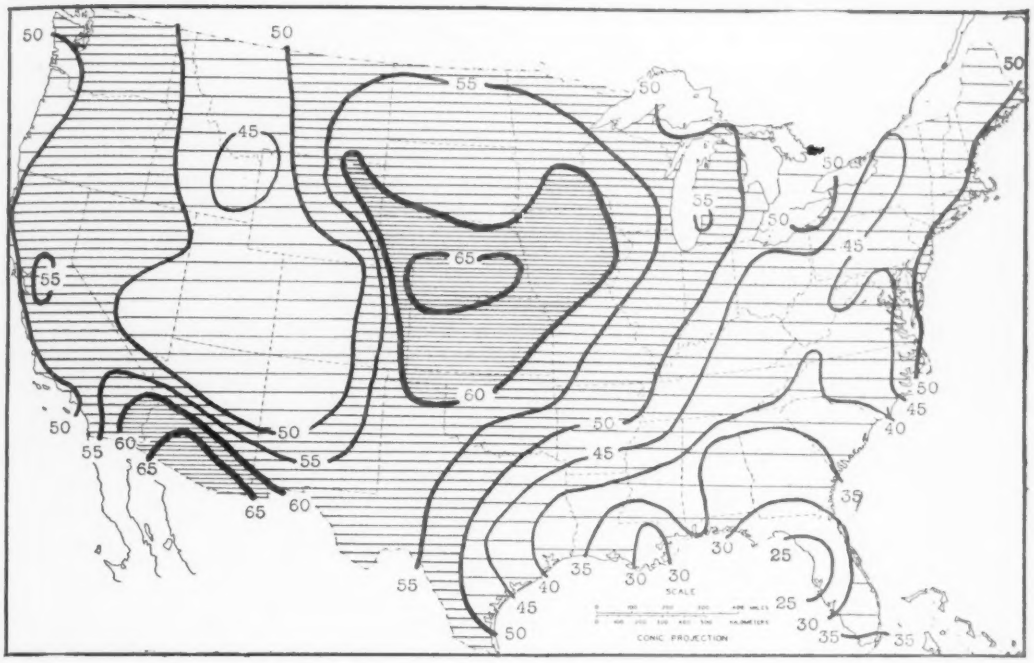
regions are shown in Map 3, which is original, although based partly on data assembled by Kincer in the precipitation section of the *Atlas of American Agriculture*. As indicated in Map 3, subdivisions of some of the regions are recognizable. In the 2- to 4-inch region, for example, New England and New York receive the most uniform precipitation, normally from 3 to 4 inches each month. Near the western margin of the same region, May and June are the rainiest months and winter is driest, whereas in an area centering in Tennessee, spring is wettest and autumn is relatively dry. The arid region also has an interesting subregion near the Mexican border where rainfall is least rare in July and August. These occasional summer rains in the Southwest help to explain the presence of the cliff dwellers, who depended largely on corn. In most of the arid region, corn was little grown by the Indians, partly because there was little midsummer rain. In the large southeastern coastal region the wettest months differ locally, but on the average come in late summer or autumn.



MAP 3. REGIONS OF DIFFERENT SEASONAL PRECIPITATION

The causes of the regional differences in the seasonal distribution of precipitation are largely results of seasonal contrasts in continental heating and cooling. The continental interior is relatively cold in winter, when winds do not often bring moisture deep into the interior. In summer, on the other hand, the interior is relatively warm, and moisture-bearing winds reach the interior much more frequently. On the average, moreover, the Lows cross the continent in higher latitudes in summer than in winter. The precipitation uniformity of the Northeast results from its numerous cyclonic storms and its location between nearby large water surfaces, the Atlantic and the Great Lakes. As many Lows move across the Lakes and along the St. Lawrence Valley throughout the year, moisture-condensing Lows are sufficiently frequent and intense even during the winter to prevent dryness in New England. The Great Lakes help to intensify the Lows, as well as yield winter moisture. The southeastern part of the United States has fewer ordinary Lows, but has more tropical cyclones which are most common in late summer and autumn; then they often yield rains heavy enough to pull the average monthly totals far above those generally attained in New England. The Pacific Coast is dry because the cool sea breezes, warmed by the land, retain their moisture.

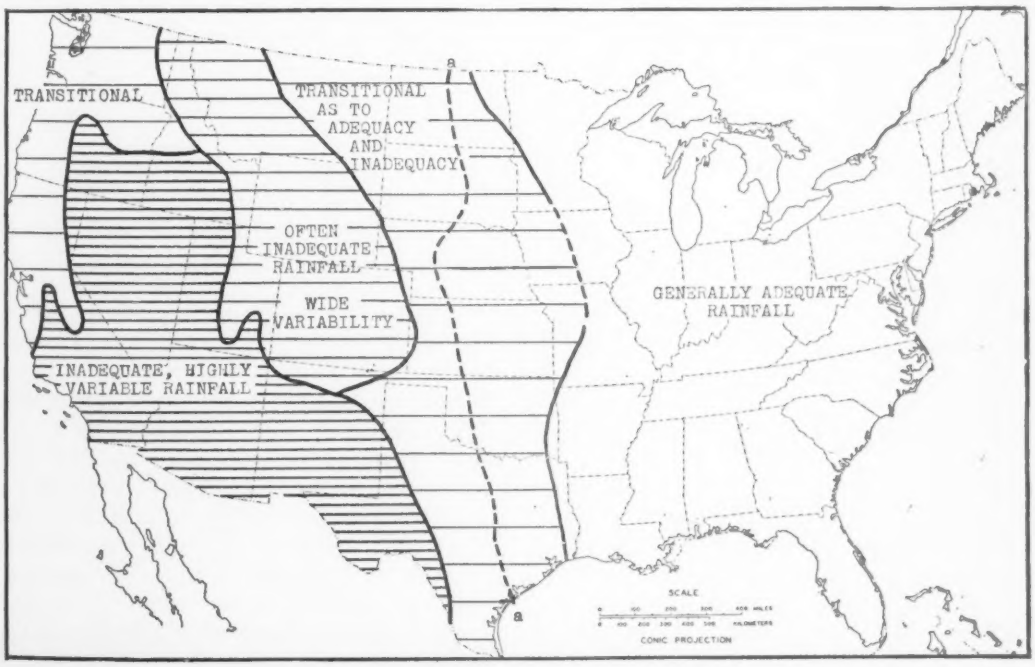
Three other sorts of regionalization on the



MAP 4. PERCENT OF WARM-SEASON RAIN FALLING AT NIGHT

basis of precipitation have been attempted for the United States: (1) the percentage of the precipitation falling at night; (2) the dependability or reliability of precipitation; and (3) the intensity or torrential character of the rainfall. The regional contrasts in these respects are presented in Maps 4–7.

Map 4 shows the percentage of rain falling

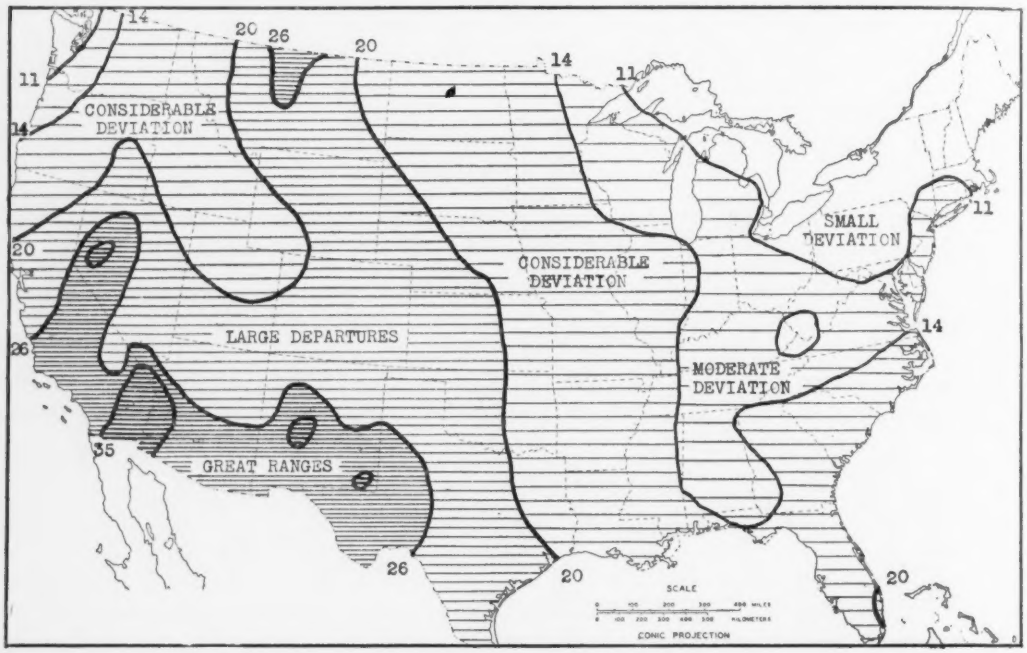


MAP 5. ADEQUACY OF RAINFALL

during twelve hours including the night (8 P.M. to 8 A.M. E.S.T.) from April to September inclusive. It is redrawn and shaded from a map by Kincer in the *Atlas of American Agriculture*. It shows that a much larger proportion of the warm season rainfall comes at night in the center of the country than in Florida. The percentage is higher in Arizona than in Idaho, reflecting greater evaporation, while falling, of daytime showers in Arizona.

Map 5 is redrawn from one by Isaiah Bowman in the 1935 Report of the Science Advisory Board (line a--a indicates the eastern limit of "Occasional Desert Years"). Florida having as much variation as North Dakota.

Map 7 is an original one based on scores of maps in D. L. Yarnell's "Rainfall Intensity-Frequency Data," U. S. Department of Agriculture, 1935, and on more than a dozen maps made by combining part of his maps, to discover the frequency (times per decade or century) of rains of various magnitudes. Also used were original maps of very heavy rainfalls which were published in the *Geographical Review* and in the *Monthly Weather Review*. The definitions of "very hard rains" and of "numerous" and "rare" are as follows: Very hard rains

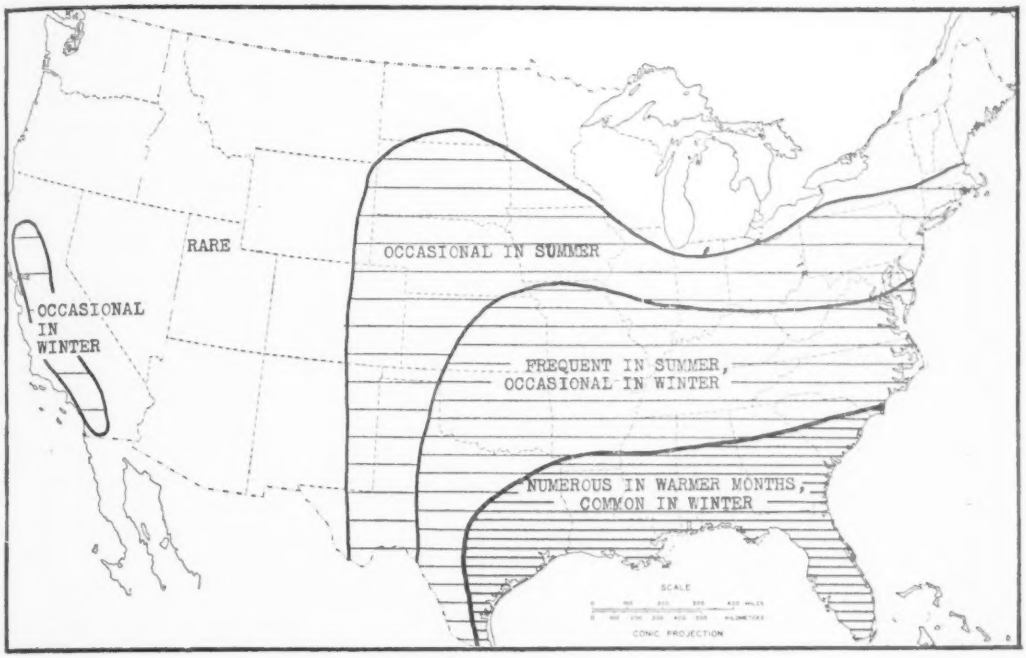


MAP 6. PERCENT DEVIATION FROM THE MEAN ANNUAL PRECIPITATION

This map shows five great regions. Perhaps its most interesting feature is the classification of the Northwest as transitional, although, unlike the transitional Great Plains, it is the region of greatest annual average rainfall.

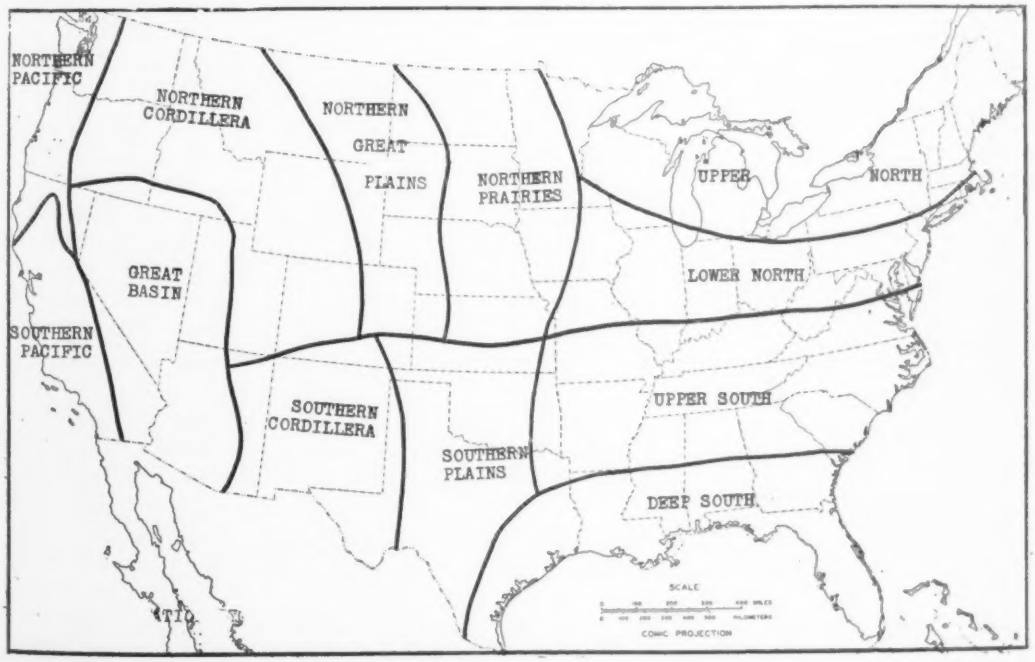
Map 6 is a redrawing (simplified and shaded) of a map of the annual deviation from the mean annual precipitation in the 1936 Report of the Water Resources Section of the National Resources Board. This map shows considerable regional contrast in the East, the North having least variation, but

are those which yield 2 inches of water within 30 minutes, or 3 inches in an hour, or 4 inches in 8 hours, or 5 inches in 16 hours, or 6 inches or more in 24 hours. Numerous means that there were 5 or more very hard rains per year. Rare means that there was only one rain of any of these 5 magnitudes during an average decade or longer. In parts of the North and West, no such rain was officially recorded at the many Weather Bureau stations in the thirty years studied. This map shows marked changes with latitude in the East, but none in the West.



MAP 7. FREQUENCY OF VERY HARD RAINS

Map 8 is a sort of summary or composite of the foregoing maps and several others. In its preparation special attention was given to the amount of rain falling in short periods and to the frequency of torrential rains of various magnitudes. Consequently, the northern and southern parts of the country are separated, instead of being combined as



MAP 8. TWELVE PRECIPITATION REGIONS

in Map 1. The latitudinal contrasts in the East are so great, according to Map 7, and to a lesser extent, Maps 3, 4 and 6, that the East is subdivided into 4 regions in Map 8. Data on which Map 8 is based, or their sources, are given in a long article in the *Annals of the Association of American Geographers*. These data refer to the central or core areas of each of the regions.

The twelve regions here delimited are not equally distinct. For some purposes two or more may appropriately be combined; for example, the East might be considered as one great region with two major subdivisions, the North and the South, each of which has two lesser subdivisions. Likewise the Pacific Coast may be classed as a region with two subdivisions rather than as two regions. The boundaries between the regions suggested in the final map are provisional, in some places arbitrary. Future studies, based on more adequate data, will permit a better drawing of the boundaries. But from the evidence at hand, it appears that the United States has distinctly more than the few precipitation regions hitherto recognized.

THE SHOWER*

The landscape, like the awed face of a child,
Grew curiously blurred; a hush of death
Fell on the fields, and in the darkened wild
The zephyr held its breath.

No wavering glamour-work of light and shade
Dappled the shivering surface of the brook;
The frightened ripples in their ambuscade
Of willows thrilled and shook.

The sullen day grew darker, and anon
Dim flashes of pent anger lit the sky;
With rumbling wheels of wrath came rolling on
The storm's artillery.

The cloud above put on its blackest frown,
And then, as with a vengeful cry of pain,
The lightning snatched it, ripped and flung it down
In ravelled shreds of rain:

While I, transfigured by some wondrous art,
Bowed with the thirsty lilies to the sod,
My empty soul brimmed over, and my heart
Drenched with the love of God.

—JAMES WHITCOMB RILEY

* From *Songs of Summer*, copyright 1908, reprinted by permission of The Bobbs-Merrill Company.

SCIENCE ON THE MARCH

THINNING FRUIT TREES BY REMOVING THE BLOSSOMS

THE cost of farm labor has nearly trebled since 1914, whereas the price of farm commodities has only doubled. In other words, efficient use of labor is more than ever important on the farm. Further, there is a shortage of labor, so that the farmer must either omit certain operations or perform them in some way that will save labor.

One of the time-consuming tasks that face fruit growers is the thinning and removal of fruit from overburdened trees in early summer so as to lighten the load and favor better size and color of the fruits that are permitted to remain. The task is usually performed by women and children, at relatively low wages. It is a time-consuming chore, the sort of thing that nobody cares especially to do, yet one that is likely to prove very important not only to the fruit but to the tree as well. For, trees which are overloaded with fruit are subject to limb breakage, winter injury, and biennial bearing—that nemesis of the fruit grower which results in a crop one year and none the next. Thus there are important implications in the possibility of "thinning" an apple tree by spraying the tree at blossom time with materials that will remove blossoms and yet leave the proper number for a crop.

But to go back a little way, the crop of fruit for 1944 was determined by the number of blossom buds formed during late spring and early summer of 1943, and this number was determined in turn by the nutritional condition of the trees. Mature trees which either did not blossom or which blossomed lightly in 1943 were likely to have formed an abundance of blossom buds for the crop of 1944; a good supply of available nitrogen is favorable to fruit bud formation under these conditions. This was the situation in many apple orchards during 1943, which was a year of light crops.

And now the season of 1944 approaches with the prospect for a heavy load of fruit, to be aggravated by a goodly supply of available nitrogen, since nitrogen tends to cause blossoms to "set" even at the expense of fruit-bud formation for the next year. Here, then, is a situation that calls for attention. Fortunately, there are suggestions from science which may help.

First of all it has been observed that the removal of blossoms may fulfill a threefold function. It "thins" the crop by removing potential fruits; it removes potential fruits at a very early stage, with much less wastage of plant materials than that caused by thinning half grown fruits; and by preventing an overload of fruit it releases sufficient available nitrogen to provide for fruit-bud formation for the next season's crop.

If all the blossoms are removed from a heavily blossoming tree, an abundance of blossom buds will be formed and the tree will blossom again the following year. A spring frost which destroys all the blossoms does this very thing. And, in this connection, it is interesting to recall that over a century ago an inquisitive horticulturist, Robert Manning of Salem, Massachusetts, laboriously picked all the blossoms from heavily blossoming Baldwin apple trees that bore fruit every other year, while leaving some trees untouched, and so brought about a condition in which some trees bore fruit one year and others the next.

Because of these benefits from blossom thinning, much attention has been attracted to it. Carefully conducted experiments in thinning blossoms of peach trees have shown increased size and color of fruit with no reduction in yield, increased size of leaf, increased terminal growth, generally increased vigor of tree, and more nearly annual bearing. Commercial peach growers, quick to adapt such findings, have already devised "rakes" or "brushes" for carefully raking or brushing excess blossoms from peach trees at the time of full bloom, with a great saving in labor.

Apple trees do not lend themselves so readily to brushing, in part because of the larger size of the trees and in part because apple blossoms commonly occur in clusters of six, in which the central flower opens a day or two (depending upon the weather) earlier than the surrounding or lateral blossoms. Further, it is when apples "set" in clusters that they become most difficult for the orchardist to handle. On the other hand, this arrange-

ment of the blossoms may enable the apple grower to destroy the lateral blossoms, as they open, after the central blossom has set.

This plan was tried, perhaps a dozen years ago, using such sprays as sodium polysulphide, cresylic acid, and tar oil distillates. When it was desired to shift the bearing years of alternate-bearing trees, these sprays proved very effective by removing all the blossoms. But when partial removal of blossoms to a desired degree was attempted, variable results were reported and in some instances severe injury was done to both blossoms and foilage, owing, in large part, to the uncertain and variable composition of the materials employed.

The new "dinitro" compounds developed for pest control (especially the material known as *Elgetol,* the sodium salt of a dinitrocresol) are of more definite composition than the materials mentioned above and can be better relied upon for blossom thinning. When certain "dinitro" sprays were applied experimentally just after the central blossom in the cluster had set, some results were very promising. Other tests have been less satisfactory, because the degree of thinning was unpredictable. Results to date do indicate, however, that these materials can used effectively on the Wealthy and Yellow Transparent varieties. Additional recommendations probably will be made as information is gathered from more extensive trials.

H. B. TUKEY

HIGH VACUUM IN INDUSTRY

EVER since 1643 when Galileo's assistant, Torricelli, discovered the possibility of producing a vacuum above the top of a mercury column by filling with mercury a tube closed at one end and over 30 inches long and then inverting it into a pan of mercury, men have been experimenting with high vacuum. Not until recently, however, have they been able to take it out of the laboratory and put it to work on a large scale in industry, where the reduction in the number of air molecules in a given space makes possible manufacturing processes that are unheard of at atmospheric pressure. The effect is something like taking a factory and moving it into the ionosphere, several miles out from the earth.

Under such conditions the boiling point of a large new class of compounds, such as oils, fats, and waxes, is reduced to a point where they can be distilled without decomposing. Many foods and drugs can be dehydrated without impairing their quality, and various metals produced directly under high vacuum.

Ordinary air pressure at sea level will support a column of mercury 760 millimeters high. In manufacturing operations now made possible by advanced vacuum techniques the air pressure is brought down to the range of .001 millimeters, or 1 micron.

To date micron pressures have been applied on a large industrial scale to the production of war-important magnesium from dolomitic limestone. The War Production Board has called this one of the most important technical achievements to come out of the war.

In addition to this, a High Vacuum Diffusion Process for pumping water vapor under high vacuum has been perfected and applied to drying penicillin. Since it materially reduces the time and cost of dehydration, according to the WPB, most of the larger manufacturers of that drug have adopted it to speed their output.

Previous to the magnesium and penicillin developments, vacuum has been used in various manfacturing processes—in the production of vitamins and the refining of certain chemicals and oils, for example. In the first instance, however, the application has not been on the large scale attained in the magnesium operation, where entire plants with thousands of feet of pipes, valves, retorts, and condensers can be placed under air pressures 100,000 times less than normal. In the second, it has been carried out at pressures in the 5 millimeter range rather than at the .001 millimeter range now attained.

Application of high vacuum to the production of magnesium was advanced when the Defense Plant Corporation awarded a contract to the National Research Corporation in Boston—which had long been doing development work in the high vacuum field—to build a small pilot plant for this purpose. Work proceeded so rapidly that four and a half weeks later this was in operation, producing a sample run of magnesium of high quality.

In making magnesium under high vacuum, bricks of crushed dolomite and ferro-silicon

are placed in a chrome-nickel-steel retort, one end of which projects into a furnace, where it is heated to 1100 degrees Centigrade. The other end, extending out from the furnace, is cooled by a water jacket. The magnesium is vaporized in the heated end and condensed in the water-cooled end, where it collects in crystalline form, the entire operation taking about eight hours.

High vacuum is essential to the process because it speeds reduction of the magnesium-bearing ore and evaporation of the magnesium molecules. In addition, the retort must be free of air because magnesium combines readily with oxygen.

Vacuum equipment designed for this installation was adapted to other large plants. Today several of the country's large magnesium producers are making the metal by this process, using new-type industrial diffusion pumps, together with associated vacuum valves, gauges, and similar parts, capable of exhausting tremendous quantities of air and other gases in record time. These installations have pumping capacities of many thousands of cubic feet per minute in the micron range, and theoretically equipment can be built for any desired pumping capacity.

Many difficult problems, however, had to be overcome before such a high vacuum could be maintained throughout a plant, making the entire system air-tight and keeping it that way. At 1 micron pressure gas expands at an enormous rate, occupying a space 760,000 times greater than it does at normal atmospheric pressure. In addition to exhausting such huge volumes of air to create the vacuum, the gases that are given off during the manufacturing operation must also be continuously removed—a tremendous job in itself, since a piece of metal at atmospheric pressure contains occluded gas at least comparable in volume to the metal itself and often several times this volume.

Keeping the system air-tight presented another important problem that had to be solved before large scale operations of this type became possible. This is an extremely complicated undertaking, since each installation of the equipment to date has created problems of its own which had to be solved individually. In short, a whole new technology of Vacuum Engineering had to be evolved.

Application of high vacuum to the drying of penicillin presented additional problems in vacuum engineering. In the past, freezing methods of dehydration at low pressure have been handicapped by the building up of heavy ice layers in compartments specially designed to collect the vapor as it is evolved. Difficulties have been experienced in attaining the required vacuum and keeping it throughout the operation, since enormous volumes of water vapor as well as air must be continuously removed. To overcome the problem of pumping this vapor under high vacuum, National Research Corporation developed its High Vacuum Diffusion Process, in which vapor and air are both handled independently in the vacuum system with different pumping methods.

Now that high vacuum systems have passed the large-scale threshold, it is predicted that in time new applications of the technique will be made. Use of the High Vacuum Diffusion Process in the drug and food fields, for example, offers great promise, and it is likely that after the war many metals may be produced simply and economically under high vacuum, as in the case of magnesium.

RICHARD S. MORSE

ROACH CONTROL

THOSE who have read the verses of Archie, the cockroach, who composed laboriously on the typewriter of his boss, Don Marquis, may have a kindly feeling toward these lowly creatures. However, most people regard cockroaches, usually called roaches or waterbugs, as unbidden and unwelcome guests. Archie, who complained bitterly about the persecution of his tribe by the human race, would, if he were writing today, have even more reason to view the future with alarm, for more effective and efficient ways have recently been developed to make his life miserable and insecure.

Mention has already been made in "Science on the March" of the use of boric acid solutions in test tube drinking fountains for control of German roaches. Experimental work is going forward to find out how many, or rather how few, test tubes should be placed in an infested kitchen and where they

should be located, first to reduce the infestation and then to prevent it from building up again. This method of roach control has not yet been tested by pest control operators, although it is more suitable for application by them than by laymen.

Not every one who finds roaches in his kitchen can afford to call a pest control operator. Therefore it is desirable to have on the market a product for roach control that anyone can buy and use safely and successfully. Hitherto a householder could do no better than buy a package of sodium fluoride, a white powder, which by law in some States is colored a greenish blue to distinguish it from flour and baking powder. The buyer then distributes this powder as best he can near places where roaches are believed to hide during the day. The results can be excellent, but the indiscriminate scattering of a poisonous powder in a kitchen where it may contaminate food and utensils should be discouraged.

Recently it was found that sodium fluoride can be molded in the form of crayons. With a crayon in hand anyone can mark on almost any surface a line of sodium fluoride—a deadline for roaches. Thus a deposit of sodium fluoride can easily be put exactly where it is needed—around window and door frames, baseboards, and sinks; in closets and drawers, and under counters or tables. With reasonable care in drawing the lines nothing will be contaminated and when the lines are no longer needed they can be wiped away with a damp cloth.

The armed forces are looking into the use of sodium fluoride crayons and if roaches carried malaria or typhus fever, these crayons would now be used throughout the world. But Archie and his cousins, being relatively harmless, are partially reprieved for the duration. After the war, however, it is to be hoped that John Doe can go to the five-and-ten and buy sodium fluoride crayons in shapes and colors that will distinguish them from chalk sticks.

Until the discovery of DDT (see the February, 1944, "Science on the March"), which may be potent for roach control, sodium fluoride was probably the most effective substance known for speedy and lasting control of German roaches. Being cheaper than DDT, it will not be easily ousted for this purpose. A thin, dry, and powdery deposit of sodium fluoride clings to the feet of roaches that walk in it. Apparently it irritates them, for they remove the deposit by licking their feet. If enough sodium fluoride is thus swallowed, the roaches succumb; if not, they are driven away. Those roaches that pick up the dust on their bodies as well as on their feet are likely to die by contact action of the insecticide. In wet places where a sodium fluoride deposit becomes caked and hard, it is not picked up by the roaches and consequently is ineffective. Therefore sodium fluoride cannot be applied successfully by spraying it in solution or suspension in water. But water is not the only liquid that might be used as a carrier for this compound.

Tests made in the laboratory and in practice during the past three years have shown that sodium fluoride can be applied in suspension in a highly refined kerosene oil in which it is insoluble. With suitable equipment the suspension can be injected rapidly into cracks, crevices, and corners where roaches hide. When the oil has evaporated, the sodium fluoride is left as a dry, powdery deposit in just the right physical condition for maximum effectiveness. In this way premises can be practically roachproofed. Improvement of the dispersion and stability of the suspension and development of suitable equipment for application remain to be done before the method can be widely used by pest control operators.

The foregoing new methods have been proved effective for practical control of German roaches but have not yet been evaluated against the larger common species: the oriental roach and the American roach. It may be found that these species can be controlled better by the use of poisoned baits, particularly by baits containing well-dispersed yellow phosphorus. Roaches are wary of most poisoned baits but the big fellows seem actually to be attracted by phosphorus, which is extraordinarily toxic to them. Much research remains to be done on attractants for roaches. Should a "roachnip" be found, Archie and his relatives might as well give up altogether.

F. L. C.

BOOK REVIEWS

WILDLIFE REFUGES

Wildlife Refuges. Ira N. Gabrielson. Illustrated. 257 pp. 1943. $4.00. Macmillan.

THIS book was originally planned to tell the story of the national wildlife refuge system administered by the United States Fish and Wildlife Service. However, as the work progressed it became increasingly evident that the history and philosophy of all types of refuges were so completely intermingled that all should be included and treated as a unit. The plan therefore was revised accordingly, and, while the book is still largely the story of our own national refuges, enough of the history and the status of all other types of refuges in North America has been included to give a rounded-out picture of conditions as they now are. While the greatly enlarged scope of the work obviously has required omission of interesting phases of the conservation story, yet, within space limitations, sufficient material has been included to give a fairly complete account of the work. Much of the information on the National refuges has been taken from the files of the United States Fish and Wildlife Service, but the book has been written against a background of personal observation on the part of the author, in which every major national refuge, except one, has been visited at least once, including most of those in Alaska, and a portion of both Canadian and Mexican parks.

An excellent idea of the general scope of the work may be gained by consideration of its major subject headings. These include such themes as: History of the refuge movement; Purposes, values and limitations of refuges; Types of refuges; Management of refuges; Alaska's great bird cities; Special refuges; The fur-seal islands; Big game refuges; General wildlife refuges; Mysterious Okefenokee; Patuxent Wildlife Research Refuge; Migratory waterfowl refuges; Refuges on land used primarily for other purposes; Refuges administered by other Federal agencies; State refuges; Private refuges, and Canadian and Mexican refuges.

Even during the period of wildest exploitation of our natural resources, there were still a few people who realized the folly of such prodigal waste, but, for a long time, their protests were little heeded by the hurrying hordes bent on conquering and consuming a continent in record time. However, these protests grew in number and in volume through the years and presently developed into the conservation movement that began its sweep soon after the turn of the last century. The story of this halting of greed and exploitation in time to save remnants that can be and are being built back into usable resources is still too recent to be completely unfolded, but it is an achievement that makes an inspiring tale and it should be repeated over and over again. Dr. Gabrielson's book presents one of the important chapters in American conservation history—the story of the growth of the great American National wildlife refuge system, now a major factor in the restoration of our wildlife resources.

J. S. WADE

EDWARD TYSON

Edward Tyson, M.D., F.R.S., 1650–1708, and the Rise of Human and Comparative Anatomy in England. M. F. Ashley Montagu. 56 Illustrations. xxix + 488 pp. Sept., 1943. $5.00. The American Philosophical Society.

As an anatomist and a physical anthropologist I was quite aware that Edward Tyson had contributed to both fields. Prof. Montagu shows in this volume that Tyson was not only a contributor—he was an originator, a founder, a pathfinder. More than that, he influenced not alone biological science but literature and human culture as well. Truly, he was of and for the period in which he lived. The research and the biographical skill of Prof. Montagu brings to life the man, Tyson, and recreates the seventeenth century scientific and social worlds in which he lived.

In 1699 Tyson published *Orang-Outang, sive Homo Sylvestris: or, the Anatomy of a Pygmie Compared with that of a Monkey, an Ape, and a Man.* In this volume Tyson states his aim "to make a *Comparative* Sur-

vey of . . . the formation and structure of all the Parts of this wonderful *Animal* . . . with the same Parts in a *Humane Body.*" This concept of a comparative study was an extension of his 1680 study of *Phocaena, or the Anatomy of a Porpoise* which Prof. Montagu says was the "first monographic study of an animal to be issued in England as an independent publication, outside the pages of a periodical." Tyson's *Orang* was a chimpanzee, and a young one at that. When he compared it to an adult human he made mistakes due to age-change differences. But this in no way detracts from the significance of his contribution of the comparative approach. Tyson's biographer goes so far as to say "no work published before or since has been so essentially a comparative anatomy as the *Orang-Outang, sive Sylvestris.*"

Tyson was not alone a research comparative anatomist, he was a physician also. He described in 1677–78 a case of suppurative cholangitis which "represents, in England at any rate, the first demonstration of the association between certain symptoms in the living and a particular pathological condition in the individual who had died exhibiting them." In 1638 he gave a thorough account of the life-cycle of the tapeworm and the roundworm.

In the field of physical anthropology Tyson provided material for the concept of Primate and human evolution, and for the classification of Mankind. It is no overstatement to say that he prepared the way for Blumenbach, often termed the father of physical anthropology. In addition, we may claim for Tyson an "honored place in the history of the scientific study of folklore." Finally, to him goes credit for pointing out "for the first time in the history of human culture, that an ape-like creature . . . was the closest living animal relation of man."

Prof. Montagu terms this biography a "labor of love"; to which the reviewer adds that most certainly love's labor has not been lost. It is clearly, vigorously written; it is carefully documented; it is copiously illustrated. Tyson and his epoch parade across the stage of Time, spotlighted by scholarly biographical research. In a *Foreword* to the volume Prof. George Sarton states that he would like to know more of Blaes, a Belgian, whose *Zootomia* or *Anatome* (1676, 1681) was the first general treatise on comparative anatomy. Prof. Sarton then says, "When will he be properly montagued?" The coined word is his, not mine—but Tyson has been most ably montagued! A good job, well done.

WILTON MARION KROGMAN

THE DEAF IN AMERICA

Deafness and the Deaf in the United States. Harry Best. xix + 675 pp. Dec., 1943. $6.50. Macmillan.

DR. BEST'S book has been awaited with interest for several years, it being known that the author of a treatise, *The Deaf,* published in 1914, had accumulated a wealth of additional material on a subject little known to the general public. The enthusiasm with which his first book was received served as an impetus for continuing the study of all phases of the deaf, and, from the wealth of material assembled, to bring together within the covers of a single book a reference work that probably has never been surpassed for intensive study and careful compilation. The exhaustive citations and references are essential in a work such as that produced by Dr. Best. Frequently publications have appeared in the past written by individuals whose work, while valuable, has reflected the personal views and prejudices of the author. It is in order to dispel such tendency and to deal equitably with a subject, concerning which there is a high degree of controversy, that the author has laid special stress on denoting the sources from which information has been gleaned. This detail makes the text doubly valuable in that it opens up a wide field for further study and investigation on the part of those particularly interested in some special field of so broad a subject.

Invariably the mind of the uninitiated turns to the charity angle when considering various phases of the handicapped groups. Because of his wide experience in the education of the deaf—the author having spent ten years as instructor at schools for the deaf in Nebraska, Washington, Alabama, and New York—he was in a position to discard the charity angle and to build upon the foundation laid down by the deaf themselves who declare that their greatest handicap is not deafness but rather the difficulty of con-

vincing a hearing world of the capabilities of the deaf. At no time have the deaf more clearly demonstrated the truth of this contention than at the present time, when shoulder to shoulder with their hearing brothers and sisters they are found satisfactorily employed in practically every field of endeavor save where hearing is an absolute essential.

Some of the leading industrialists have long espoused the cause of the deaf and have proven their premise by employing deaf men and women in various types of work where the greatest skill has been required to perform the intricate assignments entrusted to them.

Some of the chapter headings illustrate the breadth and scope of Dr. Best's work. As most of the references made to the deaf in earlier times were centered around such educational effort as was given to certain individuals, the chapters entitled "Education of Deaf Prior to Introduction into the United States" and "History of Education of the Deaf in the United States" furnish a valuable background from the historical standpoint.

The legal status of the deaf throughout the years has received a justifiable measure of attention. A chapter entitled "Legal Treatment of the Deaf" refers to legislative enactments in the various states and by the United States Government. The medical man will find much of value in such chapters as "Causes of Deafness" and "Physical and Mental Condition of the Deaf." Obviously the medical field could not be dealt with technically but the exhaustive references prove most valuable. As a matter of fact, all phases pertaining to the well-rounded life and activity of any group of individuals is here treated. Topics on religious life, methods of communication, the deaf in industry, adaptability in a world of hearing, all receive due consideration.

It is a significant fact that the author has drawn most freely upon articles printed in magazines, state and national documents, and references to the deaf found in the general run of library shelf material. He has studiously avoided the exclusive use of educational literature which has so frequently characterized work on the deaf in America.

Perhaps it is in the field of education of the deaf child that the greatest storm of controversy has raged and here the author has dealt impartially with the various contending factors. The various types of schools and the cost of such education have received abundant consideration.

The work provides an indispensable source of information for students of psychology and sociology. Every teacher of the deaf will find within its pages information that will aid in classroom problems. Parents and friends of the deaf will gain a new concept as to the capabilities of the deaf and the general public will be informed as to society's responsibility to this group.

Most significant in a study of the deaf is the fact that misleading nomenclature, such as the use of the term "deaf and dumb," or "deaf mute," has created preconceived notions of physical and mental inferiority that are contrary to fact. On this subject the chapter entitled "Popular Conceptions Regarding the Deaf" will prove illuminating.

To recount the personal sacrifices made by the author, whose very life blood flows through the pages of the book, would make interesting reading. It is merely mentioned in passing as a fitting conclusion to the review of a book which has been the focal point of attention on the part of an indefatigable student over a period of thirty-five years.

IGNATIUS BJORLEE

ORIGINS OF AMERICAN SOCIOLOGY

Origins of American Sociology: The Social Science Movement in the United States. L. L. Bernard and Jessie Bernard. xiv + 866 pp. 1943. $6.50. Thomas Y. Crowell Co.

THIS book is an account of the theory and personnel of social reconstruction in America during the 19th century. From the eighteen-forties to the eighteen-nineties social science was directly tied to reform organizations and activities. This union of science and the urge to human betterment eventually split into two parts. One component was further specialized into the several social sciences which, in due course, were institutionalized as academic disciplines. The other aspect of the movement, the interest in larger reforms, was usefully trivialized into social work, associated charities, and other welfare activities.

Intellectually, the movement began as utopian speculation, became more concrete investigation and limited agitation for specific reforms, and ended in the present-day social sciences with their historical and statistical designs of scientific studies. The early "associationist" movement, an American derivative of Fourierism, declined in the forties and the general movement took a more systematic bearing from the writings of Comte and Spencer. For many years these writings were assimilated and sometimes transformed. Their selective reception into American reform thought is well presented by the Bernards. In the seventies, political economists gave the general movement an economic welfare slant.

These economists, with other individuals interested in welfare activities and thought, founded the American Social Science Association in 1865. This association directly or indirectly gave rise to conferences on child welfare, prison and social work, as well as the several professional associations of the contemporary social sciences. In one of these special sciences, sociology, the welfare urge of the 19th century movement was continued.

The "origins" treated in this book, however, are relevant to contemporary sociology in only a limited manner. Courses in juvenile delinquency, crime, and social problems have persisted and remain quite central, but in the twentieth century the intellectual ferment in sociology has been in the fields of social psychology and social theory. These have been fertilized, and in some cases been given new orientation, by European, especially German, social thought. Nevertheless, the materials so skillfully treated here are undoubtedly among the major antecedents of contemporary sociology.

The account of how the general movement crept into respectable college and university courses is probably the most useful section of the book. A great deal of primary research was involved in obtaining precise information on the introduction of social science courses in large universities and smaller colleges. Historians of ideas and of educational institutions will be grateful to the Bernards for gathering and presenting this information.

The key interest of the social science movement of the 19th century lies in its attempt to apply science to social problems without explicit political support or tactics. It tried to blend social theory with largely nonpolitical practice. After 1900 this attempt had run its course; the larger welfare urge quite understandably became more political. Remnants of the welfare movement survived, in modified forms, in governmental bureaus and policies, and in welfare organizations. The larger urge has been specialized into respectably technical academic thinking, or has grown with the times into explicit political ideology. In the latter case, it has come to be considered inappropriate for the academic man, the governmental official, or the welfare enthusiast.

C. WRIGHT MILLS

MAN AND HIS HABITATION

Man and His Habitation. Radhakamal Mukerjee. xv + 320 pp. 1943. $3.50. Longmans, Green and Company.

PROFESSOR RADHAKAMAL MUKERJEE of the Department of Economics of the University of Lucknow, India, is one of our foremost socioeconomists, well known for his pioneering studies in Indian economic and population problems.

In this volume, which is a series of lectures delivered under the auspices of the Faculty of Science of the Lucknow University, Professor Mukerjee offers a systematized study of the materials and methods of Human Ecology as the basis of functional and quantitative sociology. This is possibly the first scientific study where the various functions and forms of human habitation with special reference to India are discussed. In some eight brilliant chapters the patterns of human habitation like the hamlet, village, small town, and city are described in relation to the density of population, physical and social nobility, man's spatial needs, and food supply.

It is interesting to find that this study suggested itself to the writer, not in the crowded plains of the Ganges Valley where he lives, but during a brief sojourn in the Middle West and the prairie country of the United States. Consequently the author has fully utilized the American contribution to his

field, particularly the discussion of Professors E. W. Burgess, Clifford R. Shaw, R. D. Mackenzie, and H. W. Odum. The result is Professor Mukerjee's canvas in the United States, in fact the whole world, though his treatment of the planning of patterns of human habitation in India is the unique part.

The scope and interest of this volume cannot be limited to any particular branch of study. As this embraces many fields it should be of considerable value to geographers, sociologists, economic planners, and social engineers.

Professor Mukerjee's study is a welcome contribution to the meager literature on the application of ecology to the study of spatial distribution of population and habitation forms. Mukerjee's scientific analysis of aggregation and concentration, mobility, specialization, distance, spatial adjustment, transportation, food supply, and urbanization is a positive contribution to strengthen the movement toward making human ecology the basis of functional and quantitative sociology.

S. CHANDRASEKHAR

NEW SCHOOLS FOR A NEW CULTURE

New Schools for a New Culture. C. M. MacConnell, E. O. Melby, and C. O. Arndt. xii + 229 pp. Nov., 1943. $2.50. Harper & Brothers.

THE Superintendent of the Evanston, Ill., Township High School (Francis Bacon) is one of those forward-looking school men who believes that experimentation by competent teachers working in a public high school may be advantageous to the pupils of that school and possibly may produce results useful to other schools. Thus his high school became the locus of an important experiment. This importance was enhanced because the school's executive officer, Mr. MacConnell, and two members of the School of Education of Northwestern University (E. O. Melby and C. O. Arndt) wished to test their talk about education by actual trial of their ideas with sure-enough school situations. The fact that during the five-year experiment Mr. Melby became Chancellor of the University of Montana did not entirely divorce him from the project before completion of this volume. The reviewer interprets the volume as a report of progress. It is to be hoped there will follow a further volume a few years later when the progress of pupils in after-school years may be fully reported.

As the title indicates, the volume is based upon the claims that schools are not now "democratic," and should become so; that the content of the course of study and ways of doing things in schools should reflect the kinds of life we should like to have people live; that each individual possesses "unique human worth" which must not be ignored; and that individuals and their groups should be guided "toward realistic appraisal of the world in which we find ourselves and toward appropriate activity in respect to it." Those claims, the authors state, hold for elementary, high school, and adult education. Indeed, much of the general discussion of the book is designed to apply to the whole program of education as well as to the particular high school used in the experiments. If science ever faces its most important problem it must apply its methods and ideals in the area of human relationships, as well as in the specific problems of biological, physical, and astronomical sciences. "For science is experimental action."

Obviously, the attitude-training of a teaching staff came first, and unsympathetic or ununderstanding staff members were supplanted by others. The most important part of retraining of teachers was accomplished by use of classes of pupils, thus teachers learned while they taught. That should always be true. Then two major subject-matter reorganizations were made. One of these produced the "core program," the other a general language course. Part of a pupil's day was devoted to selected projects, part to regular subject recitations. For example, one pupil used one or more periods in reading books and magazines or in preparation of a report on the history of automobiles. During another period this pupil was in an algebra class taught by a teacher of mathematics. During another period he was a member of a letter writing class in which all pupils and the teacher wrote real letters which a class member took to the post office. That he was called the "core postman" does not seem important. This sample pupil then reported for general language where vocabu-

lary building was studied. Next came gymnasium in which the pupil chose the type of game or exercise in which he would engage. Then the school day was over, with further free opportunity in library, on playing field, or a walk homeward. No two pupils need have identical daily programs, and pupils of different school years usually were found working together in the same class. All worked in groups of twenty-five to thirty in the ninety-minute period given to the "core program," following which individuals could devote their time to such special interest courses as commercial studies, shop work, home making, or college preparatory subjects.

The objectives, according to the author, were difficult to define because of the experimental nature of the New School. The following major objectives were recognized: reflective and critical thinking; basic skills in learning and in expression; social adjustment; subject mastery. The enlargement of these objectives, too extensive to include in a review, gives explicit meaning to them. The core program for one group or for one year changed from group to group and from year to year. No syllabus was prepared, but descriptions of the experiences of individual pupils furnished guides for subsequent school procedures.

The "evaluation of student effort" included an estimate "by the group of a student's single effort in core studies"; personal estimates of "an individual student's general effort and social effectiveness"; and reports prepared and sent home by the teaching staff. Reading the chapter on evaluation fails to give this reviewer a clear idea of desirable exactitude expected and secured in pupil achievement.

The larger part of the book is devoted to the authors' discussions of educational theory, of the need for types of education to prepare people for a "new culture," of changing attitudes and motivations so that "education becomes functional for the individual and for society." That is, "Action, controlled, co-ordinated and purposeful must be the final aim of all educational effort." These discussions are unusually cogent and will be studied with sympathetic interest by that rapidly increasing part of society which really and anxiously believes that education needs to undergo fundamental changes if it is to become our hoped-for major agency for producing an intelligently competent, an unselfishly cooperative, and an enduringly purposeful society.

OTIS W. CALDWELL

THE CHEMIST

So You Want to Be a Chemist? Herbert Coith. x + 128 pp. 1943. $1.50. McGraw-Hill.

THIS little book is enthusiastically called to the attention of those whose sons or daughters have expressed interest in chemistry or are already in technical schools of chemistry or chemical engineering. Dr. Coith gives the reader the facts of life of the industrial chemist. In a highly entertaining fashion he describes the kinds of work that chemists do in industry, the type of man that chemical industry wants, and other aspects of the subject that would help a young person to decide whether he should or could become an industrial chemist.

The reviewer was so fascinated by this book that he continued to read it on a rocking street car and on a vibrating, dimly lighted bus. If a similar book had been available to him when he was a senior in chemical engineering, in all probability he would now be working with Dr. Coith in the Proctor and Gamble Company, for, not knowing the facts of chemical life at that time, he appalled a personnel officer of P & G by an irrelevant job letter and was not hired.

Dr. Coith's book has a flavor rarely attained even by professional writers. Without resorting to the tricks of popular science writers, he is simultaneously humorous and serious, modest and wise. He knows his stuff, as the boys say. The reviewer recommends that this book be read not only by students of chemistry and chemical engineering but by everyone who has wondered about chemists and who appreciates good writing.

F. L. C.

COMMENTS AND CRITICISMS

Henry George

Mr. Davies raises some interesting points in your March issue but are his assumptions sound or his premises justified? He assumes that private earnings "may be broadly classified as payments for personal services and payments for saving" but does this show the true relationships? Do we pay "for saving" and can interest be so regarded? Is there any clear demarcation between payment for services and payment of interest? Capital, in a sense, earns its own interest by the added efficiency which tools give to labor.

What we earn may take the form of wages to be spent for today's needs, or it may take the form of capital to yield that deferred, prolonged, and greater return which we call interest. The farmer may eat up his consumption wages in eggs or in broilers, or he may hatch the eggs, accumulating capital in the form of a laying flock, but he cannot have it both ways for eggs eaten will never hatch. And of course interest is justified for otherwise he receives no compensation for foregoing today's desires.

Guesses of the share of production which goes in interest lead only to confusion, for the greater part of interest can never be unscrambled from the direct wages of labor. How much of the income of each craftsman is interest on capital in tools—the plows of the farmer, the sewing-machine of the tailor, or the kit of the carpenter? These things are all capital and, used, earn interest, but can figures for all the nation be broken down? The farmer who builds a stone-boat must forego the food which he might have been raising, but the added efficiency which the equipment gives in clearing his fields is interest on the capital produced.

Mr. Davies says that Henry George "failed to note that the original earnings of land provided funds for the early stages of capital investment," but land earns nothing: it only makes it possible for labor to earn. Rent, collected by the landlord, may or may not be spent, or invested as we say, in true capital, but, collected by the state, it is similarly invested in capital, as in roads, schools, or waterworks, and the status of rent is unchanged regardless of who gets it. What part does rent play in enabling the savage to make the bow or the canoe? Capital is always the product of labor, and operations of the market only affect its ownership. Uninvested money is capital only potentially, as is unexpended labor, and stocks, bonds, and bank balances are only vouchers representing real things which may or may not be capital.

The simple fact is that all that man has and enjoys is obtained by labor, whether of brain or brawn. Rent we must always have, as long as land differs in desirability, for it arises from this differential. It may go into private pockets, forcing the citizens to dig into their earnings to support government, but, if returned to all in the operations of government, such exactions will no longer be necessary and man's labor can be freed from this heavy toll. This, to the writer's mind, is the heart of George's philosophy.—Gilbert M. Tucker.

Corset Isn't

Allow me to draw your attention to the article that appears in the February issue of your magazine under the title "Thomas Paine: Scientist-Religionist" by Ralph C. Roper. I quote a few lines from the 1st column, page 101: "Herschel was a musician; Paine, a staymaker—of ship stays."

In the *Readers Digest* magazine, issue of March, page 78, there appears an article under the title "Tom Paine, Crusader for Common Sense" which article is condensed from *The New Leader* by Max Eastman. From page 78 I quote as follows: "Obscure British corset maker who landed at Philadelphia in Nov. 1774." Again on page 79 we read: "After leaving school at 13 he learned his father's trade of staymaker, fitting whalebone corsets."

So I am just wondering whether Tom Paine made corsets for ships or for the ladies; perhaps you can enlighten me.—H. Hall.

May I offer the following to support my claim that Paine was not a corset maker, and that he was a maker of ship stays:

Thetford, where the Paines lived, was alive with fishermen and fishing boats, and one of the main occupations was the making of ship stays.

Peter Eckler, in an early biography of Paine specifically states: "It is probable that Paine acquired in the manufacture of ship stays, the skill which enabled him to forge and manufacture with his own hands the models for his iron bridge."

The claim that Paine was a corset maker has been of more modern origin. X. Y. Z————, it is quite evident, thought it would help to sell his book to couple it with some of the worst of falsehoods. Hence, he had Paine, at the age of 13, sticking his head up against the "belly" of a 200 pound woman, in an attempt to adjust her corset, and his Quaker father swearing at him because he was not working fast enough! No, a more useful ship staymaker of the Quaker temperament is not as exciting to readers who demand not only jazz language but also jazz sentiments. It may be that Mr. Eastman, in the *Readers Digest* article, followed the lead of Z—— in classifying Paine as a corset maker. Anyhow, it is, I believe, far from the truth.—R. C. Roper.

A Scutching

Dr. Alexander F. Skutch has gently remonstrated our failure to give the scientific names of the birds that played the principal roles in his "Parable for Peacemakers" (*The Scientific Monthly,* April, 1944). Their names are as follows: The striped flycatcher is *Legatus leucophaius;* the gray-capped flycatcher, *Myiozetetes granadensis;* and the chipsacheery flycatcher, *Myiozetetes similis.* The three are members of the family Tyrannidæ.—Eds.

Transposition

Congratulations on the "new" *Scientific Monthly* with only one querulous word. Why continue the annoying habit in the book reviews of indicating the book concerned with a footnote? Everyone has to glance down and back. Since *the book* is the subject of the review for God's sake (and mine) put the significant data of title, etc., right at the head of the article.—H. E. Rawlinson.

Amen.—Eds.

Ups and Downs

In the January 1944 number there is a very interesting article on the Amazon by Albert F. Kunze in which on page 18 he says "of the newly founded city of Santiago de Guayaquil, situated *high among the peaks of the Andes*" [italics mine]. The city of Guayaquil has always been practically at sea level, only 30 miles up the Guayas River from the Gulf of Guayaquil, into which it empties.—James Birch Rorer.

Mr. Rorer, who lives in Ecuador, pointed out not only the true location of Guayaquil, but also two other errors to which we previously confessed in this column. We wish that we could send copy to him in advance of publication.—Eds.

Shall We Speak Out?

From multiplex experiential fronts
We must at times to inner room withdraw
And ponder meaning in some hope to see
Synthetic bits of universal law.

To oft emerging from that cell to light
We bring no message, yet discern the flaw.
Upon that page our shadows fell so dark
That what we drew but outlined what we saw.

At times the ego merges with the All
And lets the light of truth prevail.
Then do we feel impelled to sing
Or picture nature's wondrous tale.

In this so strange for those immersed
In scientific lore, whose life is spent
In analytic test and measurement,
Of changing form and planned experiment?

Truth comes in many forms, and beauty too,
May peer from graphs and metric formulae.
The reach of mind beyond its data soars
To make its greatest gains, and we are free
To test and seek some more.

Mankind is still emotion geared
With hymns of hate and love.
Behind the scenes stalk want and fear
And over all the crowding sphere
The master problem proves.

So therefore build and carve and draw,
Deduce, conclude and write as law
What seems so clear to you.
Fear not to seem beyond the pale
For yet no sacred mode prevails
To voice a message true.

—John G. Sinclair.

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The new *Type IV-N* plate greatly facilitates the photography of stellar spectra between 7000Å and 9000Å.

Full details about these and other Eastman plates useful for astronomy can be found in the new fifth edition of the booklet *Photographic Plates for Use in Spectroscopy and Astronomy.* A copy will be sent free upon request.

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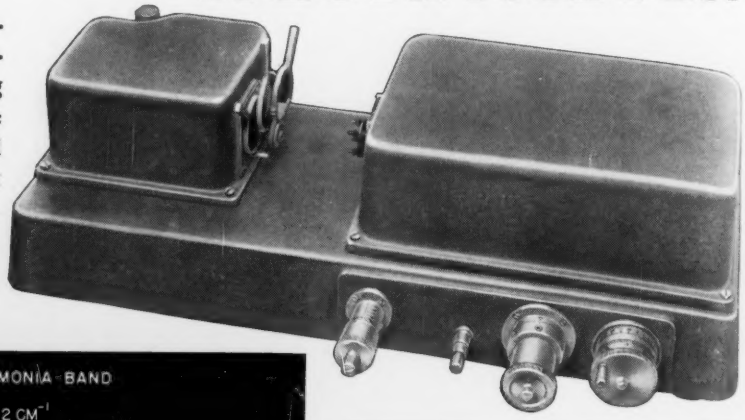

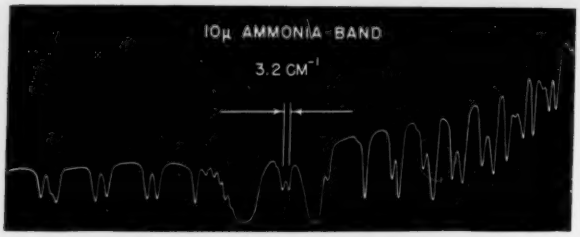

Basic Facts About Infrared Spectroscopy

THE APPLICATION of infrared spectroscopy to chemical problems is today a necessity for the chemical industry. Its usefulness in this war emergency is recognized in such diversified industries as petroleum, rubber, plastics, explosive intermediates, biochemicals, etc.

The value of this new technique lies in the fact that almost all materials exhibit characteristic absorptions in the infrared analogous to the phenomenon by which colored materials show absorption in the visible region of the spectrum. These absorptions, arising from the atomic configurations of the material, are unique for each substance and may be regarded as identifying characteristics similar to boiling point, melting point, or index of refraction. However, the infrared method has the advantage over other methods in that it offers a multiplicity of unique constants. These absorption bands have a twofold use—their wave length values offer a "fingerprint" method for identifying characteristic atomic groups or for matching unknowns, while the absorption intensity is the basis for a quick, accurate, standardized method for analyzing multicomponent mixtures.

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